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AN ECOLOGICAL INVESTIGATION OF THE BALESHED LANDING-BEN LOMOND AND AJAX BAR DIKE SYSTEMS IN THE LOWER MISSISSIPPI RIVER, RIVER MILE 481 to 494 AHP

LOWER MISSISSIPPI RIVER ENVIRONMENTAL PROGRAM
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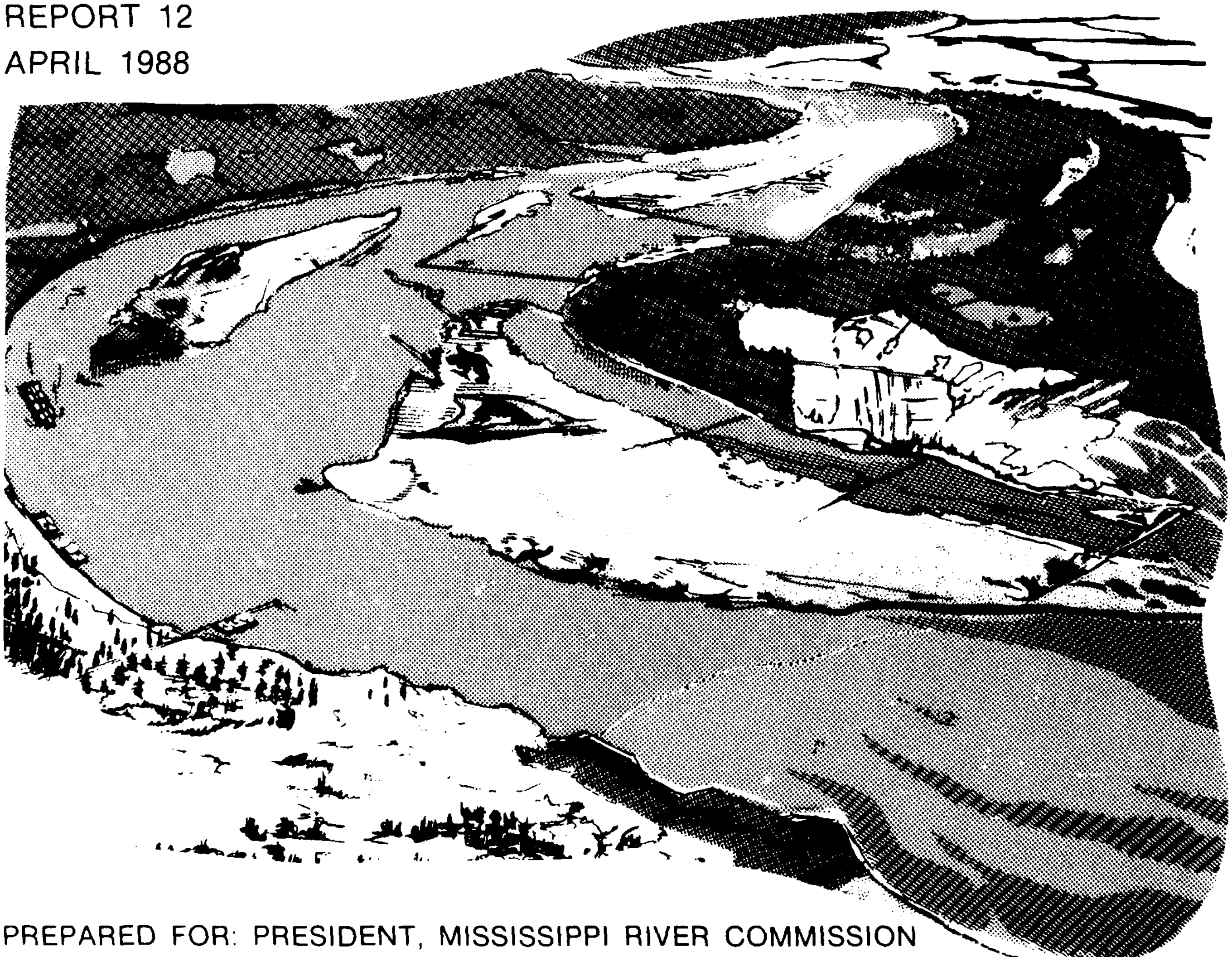

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The chemical, physical, and biological attributes of aquatic habitats associated with two Lower Mississippi River dike system pools were investigated from August 1985 to January 1986. The habitats included the dike pool at river miles (RM) 488.6 to 491.4, and the pool at RM 483.6 to 484.4. A discontinuous stretch of sandbar habitat bordering the two pools was also sampled for comparison, though at a lower level of effort.

The larger pool received substantial inflow around the channelward end of the dike, and over low points in the dike, during the entire study. Current speeds were >1.5 metres per second in most areas of the pool in all sampling periods. At comparable river stages, the upstream dike at the smaller pool was a more effective barrier to inflow. At stages below about +12 ft low water reference plane, the smaller pool isolated, and it was slack

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during most of August-October, and January. Even during the relatively high November river stage, current speeds in this pool were substantially lower than in the larger pool.

Sand and gravel sediments were common in the larger pool in all months. In August, and to a lesser extent November, substantial areas of finer sediments were also present. In the more isolated pool, fine sediments (silt-clays) comprised the majority of the sediments until January, when sands were the dominant sediment type.

Water temperature, dissolved oxygen levels, pH, and conductivity were similar in all three habitats during all sampling periods. Secchi transparency was significantly greater, and turbidity lower, in the isolated pool during August and September, but not during following months. Only in the isolated pool in September was there any indication of stratification in any water quality parameters, and the degree of stratification was slight. All water quality parameters showed seasonal variation, changing with both season and river stage.

Chlorophyll a concentrations were relatively high only in September. Concentrations were similar in the two pools, while those in the river sandbar habitat were about 50 percent lower. Phaeophytin showed a peak only in November, when concentrations were similar in all habitats. No other photosynthetic pigment was found in appreciable concentration. Estimates of primary productivity showed that the isolated pool was a site of significant photosynthetic activity in August and especially September. Estimates for this habitat were still considerably lower than for a nearby abandoned channel (Lake Providence harbor), however. Values for the larger pool and for the river sandbar habitat were negative during August, and low but positive during September.

The benthic macroinvertebrate assemblages found in sediment samples from the two pools were generally similar during both August and October. Oligochaetes, chironomids, ephemeropterans, and pelecypods comprised most of the numbers in August, while oligochaetes, chironomids, and trichopterans dominated in October. The dominant forms of chironomids and ephemeropterans differed, however, between the two pools. Samples of epibenthic organisms taken from the dikes in August indicated that trichopterans, and to a lesser extent ephemeropterans, were the dominant taxa. The macrobenthos of the two pools was considerably different during January. Chironomids dominated in both pools, but the major taxa were quite different. Only in the isolated pool did oligochaetes, ephemeropterans, and caddisflies remain relatively abundant. Although densities of sediment macroinvertebrates were not significantly different between the two pools in any month, densities were generally 200 to 400 percent greater in the isolated pool.

No substantial differences were noted between the fish assemblages of the two pools; the fish assemblage found in the river sandbar habitat was somewhat different. Fish species composition of comparable microhabitats within the pools (dike, pool sandbar, natural bank, midpool) were also quite similar in all sampling periods. Catch per unit effort for the three gear types used showed no significant overall differences among the two pools and the river sandbar habitat. Differences among microhabitats within pools were found, however, with the pool sandbar, dike, and natural bank habitats having higher catches than the midpool. Considerable differences were noted in both species composition and catch per unit effort among months.

Hydroacoustics indicated that fish were widely distributed in all microhabitats in both pools. Highest densities were generally found along the natural bank, however, and at times in the dike plunge pool. At higher river stages fish vertical distribution became more bottom- and shoreline-oriented. Target strength distributions were variable and similar in both pools.

PREFACE

The Lower Mississippi River Environmental Program (LMREP) is being conducted by the Mississippi River Commission (MRC), US Army Corps of Engineers. It is a comprehensive program of environmental studies of the leveed floodplain of the Lower Mississippi River and the main stem Mississippi River and Tributaries (MR&T) Project. Results will provide the basis for recommending environmental design considerations for the navigation and flood-control features of the MR&T Project.

One component of the LMREP is the Dike System Investigation (DSI). This report contains results of a study documenting the physicochemical environment and distribution and relative abundance of fishes and invertebrates associated with two dike systems in the Lower Mississippi River. Data were collected between river miles 484.4 and 491.4 AHP from August 1985 through January 1986.

Biological and physical data were collected by individuals from the US Army Engineer Waterways Experiment Station (WES). This report was prepared by Messrs. John A. Baker, Richard L. Kasul, C. Rex Bingham, Larry G. Sanders, and Richard E. Coleman, Dr. C. H. Pennington, and Ms. Linda E. Winfield, WES.

The investigation was managed by the Planning Division of the MRC and was sponsored by the Engineering Division, MRC. Mr. Stephen P. Cobb (MRC) was the program manager for the LMREP. The investigation was conducted under the direction of the President of the Mississippi River Commission, BG Thomas A. Sands, CE.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
acres	4,046.873	square metres
cubic feet	0.02831685	cubic metres
cubic yards	0.7645549	cubic metres
degree (angle)	0.01745329	radians
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	2.54	centimetres
miles (US statute)	1.609347	kilometres
pounds per acre	1.1209	kilograms per square hectare (10,000 square metres)
pounds (mass)	0.4535924	kilograms
square miles (US statute)	2.589998	square kilometres
tons (2,000 pounds, mass)	907.1847	kilograms
yards	0.9144	metres

AN ECOLOGICAL INVESTIGATION OF THE BALESHED LANDING - BEN LOMOND AND AJAX BAR DIKE SYSTEMS IN THE LOWER MISSISSIPPI RIVER, RIVER MILES 481 TO 494 AHP

PART I: INTRODUCTION

Background and Objectives

Mississippi River and Tributarties Project

1. Along the course of the Lower Mississippi River and on the associated floodplain, flooding has historically been a major deterrent to development. For example, destructive floods occurred in 1849, 1858, 1882, 1897, 1912, 1913, 1916, 1922, 1927, 1937, and 1973. The Mississippi River Commission (MRC) was established by Congress in 1879 to develop and carry out flood-control and navigation measures for the Lower Mississippi River that would be financed by the Federal Government.

2. The devastating flood of 1927, the flood of record, destroyed many existing levees, flooded large areas of farmland and numerous municipalities, and caused loss of livestock and human life in the Lower Mississippi Valley. This flood motivated the Congress to pass the Flood Control Act of 1928, which authorized the Mississippi River and Tributaries (MR&T) Project. The MR&T Project is a comprehensive plan for flood control and navigation works on the main stem Lower Mississippi River and tributary streams and consists primarily of levee systems, channel improvement works, and floodways. The MRC is responsible for carrying out the project.

Lower Mississippi River Environmental Program

3. The Lower Mississippi River Environmental Program (LMREP) is being conducted by the MRC. This 7-year program has as objectives the development of baseline environmental resources data on the river and associated leveed floodplain and the formulation of environmental design considerations for channel training works (dikes and revetments) and the main stem levee system. The LMREP was initiated in fiscal year 1981 and is scheduled for completion in fiscal year 1988. Fishery and wildlife populations and habitat are the main

focus of the LMREP. The LMREP is made up of five work units: (a) levee borrow pit investigations, (b) dike system investigations, (c) revetment investigations, (d) habitat inventories, and (e) development of the Computerized Environmental Resources Data System (CERDS), a geographic information system containing environmental data. This study is part of the dike systems investigations work unit.

4. As part of the channel improvement feature of the MR&T Project, the Congress has authorized the construction of 296 miles* of dikes in the Lower Mississippi River. In January 1986, 212 miles* of dikes had been constructed, about 72 percent of the authorized works. An additional 84 miles of dikes are planned for construction. Maintenance is performed on the dikes annually. The extent of maintenance is usually minor, but can be extensive if the dike's cross-sectional area becomes too small to withstand the physical forces of the river.

5. Previous US Army Corps of Engineers (Corps) investigations of the Lower Mississippi River biota have included dike systems (Pennington et al. 1980; Mathis et al. 1981; Bingham, Cobb, and Magoun 1980; Conner, Pennington, and Bosley 1983; Beckett et al. 1983; Pennington, Baker, and Bond 1983; Pennington, Baker and Potter 1983). This study, as part of LMREP, was conducted in 1985, concentrated exclusively on dike systems, and had the following objectives:

- a. Obtain comparative measurements of physical and chemical characteristics of two representative dike pools over the typical low-water season.
- b. Compare the distributions and abundances of fish and macroinvertebrates in these two pools.
- c. Compare the physical, chemical, and biological characteristics of the pools to the adjacent main channel border.

Study Area

6. The Mississippi River is the fourth largest drainage basin in the world (1,245,000 square miles), exceeded in size only by watersheds of the

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

Amazon, Congo, and Nile Rivers. The river drains 41 percent of the contiguous 48 United States and a portion of Canada.

7. The Lower Mississippi River flows from the confluence of the Ohio and Middle Mississippi Rivers at Cairo, Illinois, to the Gulf of Mexico, a distance of approximately 975 river miles (RM). At Vicksburg, Mississippi (RM 437), approximately midway along the Lower Mississippi River, the mean annual discharge of the river is 552,000 cubic feet per second (cfs); the mean monthly maximum and minimum flows are 948,000 cfs in April and 261,000 cfs in September, respectively. The maximum flow recorded at the Vicksburg gage was 1,806,000 cfs during the flood of 1927; the discharge during this flood has been estimated to have been 2,278,000 cfs if the mainline levees upstream of Vicksburg had not crevassed (Tuttle and Pinner 1982). The difference in river stage between the average minimum discharge and average maximum discharge is about 27 ft on the Vicksburg gage although river stage may fluctuate more than 45 ft in stage in a particular year. Suspended sediment transported by the river averages 161 million tons per year (Keown, Dardeau, and Causey 1981).

8. Flooding along the river may occur during the fall, winter, and spring and varies considerably in time, stage, and duration from year to year. Highest stages are typically reached from March through May. On the average, peak flows occur in April.

9. The approximately 2.5 million acres of leveed floodplain are composed of 81 percent land and 19 percent water, including abandoned channels, oxbow lakes, levee borrow pits, and the main river channel (Ryckman et al. 1975). The floodplain of the Lower Mississippi River is leveed along both banks. The main stem levees are continuous on the west bank except at the confluences of the St. Francis River and the Arkansas-White Rivers. Levee segments and bluffs alternate on the east bank. A system of dikes and revetments is being constructed throughout the river for navigation and flood-control purposes.

10. Dike structures themselves and the fluvial landforms associated with dike systems constitute a distinct type of aquatic habitat within the Lower Mississippi River ecosystem (Cobb and Clark 1981; Cobb and Magoun 1985). Within this habitat, Cobb and Magoun (1985) recognize two areas: dike system pools are the areas between adjacent dikes in a dike system; sandbars are the

areas between the middle bars, if they exist, and the adjacent main channel out to the -10 ft contour Low Water Reference Plane (LWRP).*

11. This study was conducted in the Lower Mississippi River near Lake Providence, Louisiana (Figure 1). The three habitats investigated within this reach were two dike system pools and a discontinuous stretch of sandbar habitat adjacent to these pools. One habitat (here designated as the Stack Island Pool) is located between dike 5 of the Baleshed Landing Dike system (RM 491.4) and dike 1 (RM 488.6) of the Ben Lomond Dike system. The second habitat (here termed the Ajax Bar Pool) is delineated by dikes 1 and 2 of the Ajax Bar Dike Field. The third site comprises the combined sandbar habitat along the main river channel side of the middle bars adjacent to the two pools. The engineering and physical characteristics of these dike systems are summarized in Table 1. Complete data can be found in Cobb and Magoun (1985). Throughout this report these three habitats will be referred to as the Stack Island Pool, the Ajax Bar Pool, and the river sandbar.

12. The pools can be further divided into recognizably different microhabitats, some of which are other riverine habitats on a relatively small scale (Cobb and Clark 1981). These include the natural bank, the dike plunge pool, the deep eddy usually present at the shoreward end of the upstream dike, the midpool (main body of the pool), and the pool sandbar (that portion of the middle bar bordering the dike pool itself). It is important to distinguish this last microhabitat from the river sandbar, one of the three major habitats investigated in this study. The locations of the three habitats and of the microhabitats within them are shown in Figure 1.

13. The total amount of pool and sandbar habitat contained within dike systems varies with river stage. For RM 480 to 530, Cobb and Clark (1981) estimated that dike systems comprised about 8 percent of the total available habitat during the low flow period (+13.2 ft LWRP, Greenville, Mississippi, gage). At medium flows (+24.6 ft) the contribution of dike systems increased greatly, to 28 percent. At high flows (+38.4 ft) the contribution declined to 18 percent, although actual acreage of this habitat continued to increase. The area of pools alone was estimated to be from 2 to 3 percent at low and

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* Number given in feet above the Low Water Reference Plane (LWRP): The plane of the river stage elevation for the discharge that occurs 97 percent of the time based on a long period of record. The LWRP is arbitrarily assigned an elevation of zero.

medium flows. Nunnally and Beverly (1983) estimated that dike pools constituted about 1.18 percent of the aquatic habitat at low flows in the combined Memphis and Vicksburg Districts. They used a somewhat different definition of pooled area for their calculations, however. The dike systems in our study reach comprised from 27 to 41 percent of the aquatic habitat at flow stages ranging from 0 to +15.0 ft on the Greenville gage based on 1984 hydrographic survey data.*

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* Personal Communication, S. P. Cobb, September 1986, US Army Engineer Division, Lower Mississippi Valley, Vicksburg, Miss.

PART II: METHODS

Sampling Scheme

14. Sampling began in August 1985 and continued at approximately monthly intervals through January 1986. The five sample periods were: 13-19 August 1985; 10-12 September 1985; 22 October-6 November 1985 (almost all of the work was accomplished 22-29 October); 19-21 November 1985; and 15-17 January 1986. For convenience and clarity the five periods are hereinafter referred to as August, September, October, November, and January.

15. A grid approach was taken for approximate location of sampling stations. Fourteen transects (lettered B-N in Figure 1) oriented perpendicular to the natural bank were established in each pool. Transects ran the full width of the pool and extended through the river sandbar habitat and into the main channel. Sample stations were placed along the following transects (Figure 1):

- a. Station 1, natural bank.
- b. Station 2, approximately one-fourth of the distance across the pool.
- c. Station 3, midpool.
- d. Station 4, three-fourths of the distance across the pool.
- e. Station 5, pool sandbar.
- f. Station 6, river sandbar.
- g. Station 7, main river channel.

The exact location of each station was different for each sampling period. However, the relative position of each station remained constant for each river stage condition.

Physical-Chemical

16. Dissolved oxygen (DO), pH, temperature, and conductivity were measured in situ with a Hydrolab System 8000 water quality analyzer calibrated prior to each field effort. The DO was measured to the nearest 0.1 milligram per litre (mg/ℓ), temperature to the nearest 0.1° C, pH to the nearest 0.1 unit, and conductivity to the nearest μmhos/cm. During each sample period measurements were taken in each pool from stations 1, 3, and 5 on transects C,

F, H, K, and M at 1-metre (m) intervals from surface to bottom. Measurements were also taken from two stations in the river sandbar habitat. Water transparency was determined with a secchi disc at each hydrolab station. In addition, water samples were collected at twice the secchi disc depth at each station and transported back to the laboratory on ice, in Nalgene 500 millilitre (ml) amber polyethylene bottles, for chlorophyll and turbidity analysis. Water samples were processed in the laboratory within 24 hr of collection. Turbidity was measured to the nearest NTU with a Hach Model 2100A turbidimeter, calibrated against a chlorobenzene solution (American Public Health Association (APHA) 1975). Laboratory procedures for preparing and reading chlorophyll extracts followed those proposed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) (1966) with two exceptions: extracts steeped 15 to 20 hr before centrifugation and supernatants were acidified with 1.0 N HCl after reading chlorophyll values to determine the phaeophytin value. Chlorophyll and phaeophytin concentration calculations followed UNESCO (1966) and APHA (1975).

17. Current velocity and sediment mapping was performed during August, October, and January. Current speed and direction were measured (Endeco meter) at 1-m intervals from surface to bottom at 45 sampling stations evenly spaced throughout each pool. A single sediment sample was also obtained from each station using a Shipek grab. The sediment type was visually classified in the field, and a subsample was retained. Visual classes included mud, mud and fine sand, fine sand, medium sand, coarse sand and gravel, mud and medium or coarse sand, and consolidated clay. Five randomly selected subsamples from each major sediment type identified in the field were analyzed for grain size (US Army Corps of Engineers 1970) to verify the accuracy of the field categorizations. If fewer than five of any category were available, all were analyzed. Sediment grain sizes were grouped into five categories: particles larger than 4.76 millimetres (mm) constituted gravel; particles 4.76 to 2.00 mm were coarse sand; those 2.00 to 0.42 mm comprised medium sand; particles 0.42 to 0.074 mm were fine sand; and the silt-clay fraction was particles less than 0.074 mm.

Productivity

18. Primary productivity was measured during August and September in the three study habitats (Figure 1) and also in two nearby slack-water sites (Lake Providence Harbor and a borrow pit). Productivity was the only portion of the study performed in the two slack-water sites. Productivity was estimated using the light-dark bottle technique. Three pairs of light and dark bottles were suspended at each of three depths in each of the five sites. The depths represented values of 80-, 50-, and 0-percent light penetration. Light readings were taken with an underwater irradiometer (Kahl Scientific, Model 268WA310). Bottles were incubated for 2 hr centered around solar noon. Water samples from each depth were collected with a Van Dorn sampler, iced immediately, and fixed with concentrated sulphuric acid. Oxygen concentration was determined in the field using a Winkler titration. Concurrently with the productivity incubations, water chemistry measurements were made in situ with a Hydrolab 8000 meter and included DO, conductivity, pH, temperature, and oxidation-reduction potential. Readings were taken at 1.0-m-depth increments at the bottle station and at surface, middepth, and bottom at four additional nearby stations. Turbidity was measured with a Hach Turbidometer, and the Secchi disk transparency was determined. Measurements of nitrates, nitrites, organic nitrogen, total phosphorus, dissolved and suspended solids, and total organic carbon were also made. Samples for solids, nutrients, and turbidity were collected from both near the surface and near the bottom.

Fish

19. Fish were collected during every sample period in each pool and along the river sandbar by utilizing seines and electrofishing equipment. Gill nets were set in each pool whenever conditions permitted. Seining was conducted with a 15- by 4-ft net having 1/8-inch (in.) square mesh. The number and exact location of seine hauls varied with river stage. Seine hauls were approximately 50 ft long and were made in the direction of the current (when present) and parallel to the shore. Experimental gill nets were 150 ft by 12 ft, with six, 25-ft-long panels having square mesh sizes ranging from 1 to 3-1/2 in. Up to five 24-hr gill net sets were made per pool each sample period, depending on river stage. Electrofishing was conducted with a Coffelt

boat-mounted electroshocker utilizing pulsed alternating current. Output characteristics were adjusted to maximize shocking efficiency and varied between 110 to 220 volts (V) and 5 to 8 amperes (A). Electrofishing samples were taken along the dikes, the natural bank, the pool sandbar, the river sandbar, and in midpool. Lengths of transects were determined by the size of the microhabitat being sampled and ranged from 4 to 12.5 minutes (min). The number and location of transects varied with river stage.

20. Larger fishes were identified and processed in the field; smaller fishes were preserved in 10 percent formalin. Fishes were identified to species, measured (total length to the nearest millimetre), and weighed (nearest gram (g) in field, nearest 0.1 g in laboratory). Fishes processed in the field were returned to the river; those taken to the laboratory were stored in 50-percent isopropanol.

21. On 27-29 September 1986, a 2-acre portion of the nearly isolated dike pool immediately upstream of Ajax Bar Pool was rotenoned. The sampled portion was bordered by the natural bank and a large sandbar. The distance between the natural bank and the sandbar was approximately 400 ft. Maximum depth of the pool was 18 ft. The area was blocked off with 20-ft-deep, 0.5-in.-mesh nets, and 1 mg/ℓ of emulsified rotenone solution was applied over a 2-hr period. Fish were collected for two consecutive days.

22. Hydroacoustic data on fish abundance and distribution were collected using a BioSonics Model 101 Dual-Beam Echo Sounder operating at 420 kilohertz (kHz), a BioSonics Model 171 Tape Recorder Interface, a Sony SL-2005 Video Cassette Recorder, an EPC Model 1600 Chart Recorder, a BioSonics Chart Recorder Interface, a Hitachi Oscilloscope, and a 420-kHz dual-beam transducer mounted in a Endeco Towed Body. During a survey, the transducer unit was suspended in the water alongside the survey vessel at a depth of about 0.5 m and was towed on transect through the water at a constant engine revolutions per minutes (rpm). Echo return data were recorded as electronic signals on videocassette tape and as echograms on chart recorder paper. Data were returned to the laboratory for analysis. A detailed description of a typical hydroacoustic system and how it functions is provided by Burczynski (1979).

23. Stack Island and Ajax Bar pools were surveyed during August, November, and January. Each pool was sampled twice in each month, once in the morning and once in the afternoon of consecutive days. Each survey was performed along fixed transects that traversed major hydrographic and

microhabitat features of the pools. Stack Island Pool surveys consisted of 14 transects ranging in size from about 400 yards (yd) for those across the pool and along the dikes to 2,900 yd for the 3 transects that traversed the length of the pool (Figure 2). Ajax Bar Pool surveys consisted of 12 transects ranging in size from about 150 yd in the scour hole to 900 yd along the natural bank.

24. Data acquired on videocassette tapes were processed to determine target strengths (relative fish sizes) using a Sony VCR, tape recorder interface, BioSonics Model 181 Dual-Beam Processor, and an IBM personal computer. Echograms were digitized to determine fish densities and spatial distributions.

Macroinvertebrates

25. Macroinvertebrates were collected during the August, October, and January sampling periods. A single bottom sample was collected with a Shipek grab from stations 1, 3, and 5 on transects F, H, and J, respectively, in each pool. Samples were sieved through a 0.5-mm-mesh screen in the field and immediately preserved in 10-percent formalin. In the laboratory, invertebrates were transferred to 70-percent ethanol and stained for at least 48 hr with Rose Bengal. Initial sorting was done under 3X circline lamps. Invertebrates were identified to the lowest possible taxon.

26. Epibenthos on the dikes were collected during August from transects B and N (the transects on the dike faces inside the pool) within Stack Island Pool. At each of five stations, two samples, each consisting of three stones obtained from a depth of 0.5 m, were collected. Invertebrates were removed from the stones in the field. Sample preservation and processing were the same as for bottom samples.

Analytical

27. Fish, macroinvertebrate, and water quality data were evaluated by analysis of variance (ANOVA) to determine if there were differences among the three habitats or among the five months. Water quality variables were additionally examined for differences due to depth. Macroinvertebrate samples were evaluated on the basis of total density and total number of taxa. Fish

data were evaluated on the basis of the numerical catch per unit effort by each of the three gear types separately; weight was tabulated but not analyzed due to its extreme variability and the generally small number of samples taken. Units of effort for electroshocker, seines, and gill nets were a 10-min shocking run, a single seine haul, and a single net-day, respectively. Fish and benthic data were log transformed prior to analysis.

28. For fish, differences in catch per effort among the five months were tested for each pool and the river sandbar separately. Mean values for the pools were derived from all samples and adjusted for differences among microhabitats. Differences among microhabitats within the pools were tested combining all samples and adjusting for differences due to month. Finally, differences in catch per unit effort among the three habitats (Stack Island Pool, Ajax Bar Pool, river sandbar) were tested using all combined samples adjusted for both month and microhabitat.

29. Vertical profiles and estimates of fish density were extracted from echograms using a digitizing tablet connected to a microcomputer. Targets were electronically marked, indicating their exact position from the beginning of the transect, their depth in the water column, and the depth of the pool bottom immediately below them. Fish counts and positional readings were automatically transmitted from the digitizer to structured data sets in the microcomputer, which were later analyzed for density and distributional information.

30. Fish density was calculated as the number of fish per hectare of pool surface area. Three computations were performed in order to calculate fish density on each survey transect. First, fish were weighted by 1/(2*R*tan*Θ)/2) as an adjustment for the increased sample area at increased range (R) from the transducer. This computation effectively scaled the transect width to 1 m for all sampled depths. An effective beam angle (Θ) of 7.5 degrees (deg) was used for these calculations. Weighted counts were then totaled for each transect and divided by the length of the transect to arrive at fish density, and the result was then scaled to a per hectare basis. Transect lengths used in scaling calculations were estimated using measurements taken from Corps bathymetry maps dated 10-15 January 1986 combined with relative transect times taken from the data recorder's tape counter.

31. Depth and surface distribution profiles of fish were computed using positional information recorded from the echograms. Both surface and depth

profiles were based on fish counts weighted by 1/R to adjust for the conical shape of the sampling beam. Thus, summaries were based on depth-weighted counts rather than actual counts. Data for depth profiles were classified into 2-m depth intervals and summarized by strata interval. Profile summaries were computed only where at least 10 fish could be assigned to the same water depth interval.

32. Target strength measurements were made using the BioSonics Model 181 Dual-Beam Processor. Aided by operator entered parameters, the processor separated single fish from unusable multiple fish echoes, estimated the position of each single target in the acoustic beam, and calculated a target strength adjusted for target position. Target sizes measured by the process in millivolts (mV) were converted to decibels (dB) expressed relative to transmitter voltage output. The smallest target processed was set to a threshold of 300 mV (-60 dB). Target strength is an inherent property of fish that is generally related to overall fish size. But target strength can differ for different species of fish, or even the same individual fish, with varying orientations to the acoustic beam axis. Because species and orientation information was not, and usually is not, available from in situ measurements on fish obtained during survey sampling, it was not possible to accurately relate measurements of acoustic size to the actual size of individual fish. Target strength was assessed in the customary reporting units of decibels. But for convenient presentation in familiar units, target strengths in decibels were also presented in inches by using a regression equation developed by Love (1971). This equation was developed from laboratory measurements of target strength made on several species of fish, all of which were centered in the acoustic beam and positioned horizontally in the water at the time of measurement. Consequently, it is only an approximate indication of relative fish size for in situ measurements and does not necessarily indicate actual fish size. Acoustic noise resulting from turbulence and high current velocities interfered with target strength processing in some instances. Target strength summaries were edited before presentation to eliminate those that might have been affected by acoustic noise.

33. Comparisons of mean fish density between the two pools, among microhabitats within pools, and among times were made using a completely randomized ANOVA. Transect density values were transformed prior to analysis by taking

the logarithm of 0.5 plus the transect density. Comparisons of particular interest were made as linear comparisons from the ANOVA.

PART III: RESULTS

Water Quality

34. River stage fluctuated among sampling periods, from about 2 ft on the Lake Providence gage in August to about 20 ft in November (Figure 3). The water quality variables also fluctuated among periods (Figure 4), apparently responding to both river stage and season. Few substantive differences were found either between the two pools, or between the pools and the river sandbar. Similarly, with few exceptions the three habitats were rather well mixed, showing little evidence of stratification. Additional water quality information can be found in the section on productivity later in this report.

35. Water temperature did not differ significantly among the three habitats in any month ($F = 0.98$; $P > 0.25$). However, temperatures were significantly different among months ($F = 12.55$; $P < 0.001$), with the five months falling into three distinct groups (Figure 4). Water temperature ranged from about 3-4° C in January to 28-29° C in August. Temperatures were similar during August-September and during October-November; between these two periods, and between October-November and January, temperature dropped considerably. Dissolved oxygen concentrations were negatively correlated with water temperature ($r = -0.96$; $n = 5$; $P < 0.05$), being lowest in August-September (about 6.0 mg/ℓ) and highest in January (about 11-12 mg/ℓ). As with temperature, no differences in DO concentrations were detected among habitats within any month; oxygen concentrations did differ significantly overall among the five months, however, ($F = 9.52$; $P < 0.001$). Neither temperature nor DO showed any significant correlation with depth in any habitat in any month (all $r < 0.50$; $P > 0.25$). Temperature and DO concentration appeared to be most strongly influenced by season.

36. Conductivity and pH varied relatively little during the study (Figure 4), the overall ranges being only 392 to 420 NTU and 7.3 to 7.7, respectively. No significant differences were found among the three habitats during any month. However, values were extremely consistent within each month, so that significant differences were observed among months. Conductivity was significantly lower in September and January than in the other three months ($F = 4.25$; $P < 0.01$); pH was significantly higher in September than in the other months ($F = 3.99$; $P < 0.01$). No significant differences due to depth

were found in any month. Probably due to the low variability and the low number of sampling periods, neither conductivity ($r = 0.54$; $n = 5$; $P > 0.25$) nor pH ($r = 0.44$; $n = 5$; $P > 0.50$) were significantly correlated with river stage.

37. Secchi transparency and turbidity were negatively correlated ($r = -0.99$; $n = 5$; $P < 0.05$), as expected (Figure 4), and both variables appeared to vary temporally as a function of river stage. Secchi transparency was significantly ($F = 7.25$; $P < 0.01$) greater (and turbidity lower) in Ajax Bar Pool than in Stack Island Pool or in the river sandbar habitat during August and September, but not during the following months.

Chlorophyll

38. Concentrations of all forms of chlorophyll (Figure 4) showed generally similar seasonal patterns at all three habitats (the two pools, plus the river sandbar). Chlorophyll a concentrations were moderate (about 8-13 micrograms per litre (μg/ℓ)) in August. During September, concentrations rose dramatically, reaching 29-32 μg/ℓ in the two pools and nearly 19 μg/ℓ in the river sandbar habitat. By October, concentrations were low, and they remained so thereafter.

39. Phaeophytin a concentrations showed the same temporal pattern at all habitats with the exception of the river sandbar in August, where values were relatively high compared to the pools. In contrast to chlorophyll a, phaeophytin concentrations peaked in November.

40. Chlorophyll b showed a very low range of values in all habitats across all sampling periods. Chlorophyll c, however, showed somewhat more variability and also generally higher average concentrations. This form showed a seasonal pattern like that of chlorophyll a, peaking in September in the two pools. The river sandbar, however, showed no September peak, and values there were actually highest in August.

Current Velocity and Sediments

Current velocity

41. Current velocity and sediments were intensively sampled in August, November, and January at river stages of about 2.0, 18.5, and 6.5 ft on the

Lake Providence gage, respectively.* During August, water entered Stack Island Pool primarily between the end of the dike and the upstream end of the middle bar. Inflow passed either immediately downstream through the pool or moved parallel to the dike toward the natural bank. There were relatively little turbulence and few major countercurrents, at least compared to higher river stages. One large eddy was present at the shoreward end of the dike, however. Current speed was highest through the center of the pool (Figure 5), and it diminished near the natural bank and pool sandbar. The main exit point was between the downstream end of the middle bar and the outer tip of the downstream dike.

42. Current pattern through the midpool area of Stack Island Pool remained essentially unchanged at the two higher river stages, although current speeds increased somewhat, especially in November. Turbulence and countercurrents increased near the upstream dike in both later samplings due to increased inflow over parts of the dike. At these times a relatively larger amount of outflow occurred over parts of the downstream dike.

43. The upstream dike at Ajax Bar Pool was a more effective barrier to flow than was the upstream dike at Stack Island Pool. During August, for example, when river stage was about 2.0 ft (5.7 ft LWRP), only a very small percentage of Ajax Bar Pool had detectable currents (Figure 6). Inflow to the pool was entirely along the upstream end of the island; flow returned to the river primarily along the upstream dike, except for a very small but swift outflow between the downstream end of the middle bar and the downstream dike.

44. At stages above about 12 ft LWRP a substantial amount of surface flow entered the pool through a low point, in addition to that entering across the now submerged middle bar. Exit from the pool continued to be near the downstream end of the middle bar, although outflow was also occurring through several low points in the downstream dike. Considerable turbulence was present near the upstream dike; however, at no time did it approach that at Stack Island Pool. A small chute situated about 100 ft inland of the natural bank

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* The zero point on the Lake Providence gage is 69.71 ft; on this same scale the 0.0 ft on the LWRP is 66.00 ft. Therefore, gage readings for Lake Providence can be approximately converted to feet above the LWRP by adding 3.71 ft to the gage reading. This conversion allows comparison of river stage and dike crest elevations, which are also given in feet above the LWRP.

was slightly connected at the second and third physical samplings. During November there was some flow through this chute.

45. At stages above about 15 ft LWRP both dikes of Ajax Bar Pool were almost totally submerged, and substantial inflow occurred across the completely submerged middle bar. Turbulence and crosscurrents were observed near the upper dike (at an 18.5 ft stage), but they were less noticeable than at the intermediate stage (14.0 ft). With the exception of two small areas, flow through this pool at relatively high stages is nearly directly upstream to downstream. One small area near the natural bank had a distinct backflow; another area near stations E03 and F03 experienced turbulence and swirling flow due to the meeting of the two major inflow currents.

Sediments

46. Sediments found at Stack Island Pool were relatively diverse, ranging from coarse sand and gravel to mud (Figure 7). Sampling at the lowest stage, in August, indicated mostly coarse sand and gravel near the upstream inflow point, and extending through the upper center of the pool, areas where current speeds were generally high. Along the natural bank appreciable amounts of mud or mud-fine sand were observed, along with several areas of consolidated clay. Medium to fine sands, and mud-fine sand, were found in most areas along the pool sandbar. In areas of higher currents in the lower one-quarter of the pool, coarse sediments were found.

47. During the highest sampling stage, 18.5 ft in November, a shift to coarser sediments overall was observed in this pool, although mud-fine sand was still present along the natural bank and near midpool. The January sampling followed the rise in stage that was only just beginning during the November sampling (see Figure 2). In January nearly all areas except those immediately along the natural bank had coarse sediments.

48. With few exceptions, bottom grabs at Ajax Bar Pool in August were composed of mud and mud-fine sand (Figure 8). In November, substrates remained primarily mud-fine sand, although coarser sediments were found along the recently inundated sandbar. In January, following the November-December river rise, many areas of this pool contained primarily medium and fine sand sediments, although 20 percent (9 of 45) of the stations still had mud or mud-fine sand bottoms. Gravel was common only immediately downstream of the dike.

Productivity

49. Water quality information obtained during the 2-month productivity study is presented in Table 2. As noted in the earlier section on water quality, relatively small differences in all measured variables were noted among Stack Island Pool, Ajax Bar Pool, and the river sandbar in either month. Ajax Bar Pool showed weak stratification in the bottom few metres during September, as indicated by the low-end values for DO and oxidation-reduction potential. Lake Providence Harbor and the borrow pit differed from the other three habitats, and also from each other, in several ways (Table 2). Lowest values for most parameters were measured in the borrow pit, where pronounced temperature, DO, and oxidation-reduction potential changes occurred at a depth of about 4 m. Lake Providence Harbor showed less tendency toward stratification and oxygen depletion than did the borrow pit, and more closely resembled Ajax Bar Pool. In August the harbor was more stratified than Ajax Bar Pool, while in September the reverse was true. Conductivity and pH were lower in the borrow pit in both months than in the other four sites, where values were similar. In September, conductivity was very high in the harbor, and both the harbor and the borrow pit had slightly lower pH levels than the other three sites.

50. Dissolved and suspended solids, and total organic carbon, were similar in the two pools and the river sandbar habitat during August (Table 3). Dissolved solids were somewhat lower in the borrow pit, and suspended solids were considerably lower in both the borrow pit and the harbor. In September, after a long period of relatively low river stages, dissolved solids were higher in Ajax Bar Pool (the most isolated pool) and in Lake Providence Harbor. Values at the other three habitats were lower and similar to the values recorded in August. Suspended solids were low in all habitats except the river sandbar. Total organic carbon concentrations were similar to those found in August in all habitats except the borrow pit, where measurements indicated much lower concentrations.

51. Nitrites were generally at or below detection limits, while nitrate nitrogen ranged from very low to very high (Table 2). Nitrate concentrations showed an interesting pattern among the five habitats. In August, values were high (1.09-1.95 mg/ℓ) except at the borrow pit, where very low values were encountered (0.01 mg/ℓ). Values declined in September to moderate levels in the river sandbar and Stack Island Pool and to moderately low levels in Ajax

Bar Pool. Concentrations found in Lake Providence Harbor and the borrow pit were extremely low.

52. The organic form of nitrogen (total Kjeldahl nitrogen (TKN)) was present at moderate to high levels in all habitats in both months (Table 2). Values were generally highest in Lake Providence Harbor and the borrow pit, however. In August, ammonia nitrogen levels were near detection limits in all habitats except the borrow pit. In September, values were moderate to high in the three slack-water habitats (Lake Providence Harbor, borrow pit, Ajax Bar Pool) and very low in the two flowing-water habitats (river sandbar and Stack Island Pool).

53. The highest gross and net productivity was found at Lake Providence Harbor during both months (Table 4). In August, productivity estimates were low but positive at the borrow pit and Ajax Bar Pool, and negative at both Stack Island Pool and the river sandbar. In September, all habitats showed positive productivity values, and values were especially high in Lake Providence Harbor and Ajax Bar Pool. Productivity estimated for the borrow pit actually declined in September.

Biological

Macroinvertebrates

54. August. Oligochaetes, chironomids, ephemeropterans, and pelecypods comprised most of the benthos in August (Table 5). The predominant oligochaetes in both pools were immature tubificids without capilliform chaetae, and adult *Limnodrilus maumeensis*. The dominant ephemeropterans differed, however; *Stenonema integrum* was the most common species in Stack Island Pool (Table 6), while *Hexagenia* sp. was most abundant in Ajax Bar Pool (Table 7). A number of species of chironomids were found in low to moderate abundance in the two pools. *Harnisha curtilamellata* was most abundant in Stack Island Pool, while *Chironomus* was the most common taxon in Ajax Bar Pool.

55. The benthic assemblages in the two pools during August consisted primarily of collector organisms, such as deposit feeders (Oligochaeta), gatherers (Chironomidae), and filterers (Chironominae, Trichoptera, and Pelecypoda). Predatory organisms comprised less than 2 percent of the macroinvertebrate numbers, and only a single predator species (*Coelotanypus*) was collected.

56. August dike samples yielded a total count of 1,920 organisms; the upstream face (transect N) yielded 1,129 organisms and the downstream face (transect B) 791 organisms. Of the 29 taxa found, Trichoptera accounted for 61 percent (Table 5). Hydropsyche orris was the most common species, and trichopteran pupae were common as well. Stenonema integrum, Polypedilum convictum, and P. illinoense were also present in appreciable numbers (Table 6). An average of 96 organisms/sample was found in the dike rock samples.

57. Collector taxa dominated the dike samples, with the filter-feeding caddisfly H. orris and the chironomids Polypedilum convictum and P. illinoense dominating (Table 6). Stenonema integrum was the dominant gatherer. The Oligochaeta, primarily deposit feeders, were represented by very few individuals.

58. October. Oligochaetes, chironomids, and caddisflies were common to both pools in October, and these groups were represented by much the same taxa (Tables 6 and 7). Mayflies remained prominent in Stack Island Pool, but were absent from Ajax Bar Pool, despite the presence of apparently suitable habitat for at least the genus Hexagenia.

59. Collectors were again the dominant form in macroinvertebrate collections. Deposit feeders in both pools were dominated by immature tubificids without capilliform chaetae (Tables 6 and 7). Gatherers found in Stack Island Pool were primarily Cryptochironomus and Hexagenia, while in Ajax Bar Pool they were Cryptochironomus and Ablabesmyia annulata. The predominant filterers were caddisflies in both pools. Predatory taxa encountered included Bezzia, Coelotanypus, and Dromogomphus in Stack Island Pool, and Tanypus stellatus and Hemiptera in Ajax Bar Pool.

60. January. The macrobenthos of the two pools diverged considerably during this month (Table 5). Chironomids dominated both pools, but the major taxa identified were quite different. Chernovskiia orbicus and Robackia claviger were found in Stack Island Pool (Table 6); a larger mixture of taxa were collected in Ajax Bar Pool, including Cryptochironomus, Coelotanypus, Goeldichironomus, and Procladius (Table 7). Copepods and tubificid oligochaetes comprised most of the remaining benthos in Stack Island Pool, with tubificids being relatively minor. Oligochaetes were considerably more abundant in Ajax Bar Pool, and in addition, this pool yielded a relative high number of both mayflies and caddisflies.

61. In January, gatherer species were more abundant than deposit feeders in both pools. In Stack Island Pool, the chironomids C. orbicus and R. claviger were the dominant species in this feeding group (Table 6). The dominant gatherer chironomids in Ajax Bar Pool, however, were Cryptochironomus and Goeldichironomus (Table 7); the mayfly Hexagenia was also a commonly collected member of this group. The deposit-feeding collectors were again represented mostly by immature tubificids without capilliform chaetae. Filterers were relatively uncommon in January; they were again represented by caddisflies, mainly H. orris. Chaoborus, Bezzia, and Coelotanypus were the most numerous predators. Predatory taxa increased substantially in overall abundance in Ajax Bar Pool, accounting for over 19 percent of the total numbers at this time.

62. Densities of macroinvertebrates in the two pools were quite variable among samples, resulting in high variances about the means (Tables 6 and 7). In no sampling period were density estimates for the two pools significantly different ($P \gg 0.25$ in all cases). In August and January, however, densities of organisms in Ajax Bar Pool exceeded those in Stack Island Pool by nearly 200 and 400 percent, respectively. Density estimates for the two pools were equal in November.

63. Highest densities of organisms were generally encountered from mud or mud-fine sand substrates, while density estimates from coarser substrates (primarily sands) were low or zero in most instances. The Spearman rank correlation between mean total macroinvertebrate density and substrate category was highly significant ($T = 5$; $n = 7$; $P < 0.005$).

Fish

64. General. Due to a rise in river stage in late Autumn (Figure 3), sampling effort by gear type was not consistent over time (Table 8). Seine and gill net efforts were reduced by one-half in October and November in the Stack Island Pool (compared to August and September levels), and dike electrofishing was completely eliminated. In Ajax Bar Pool, the number of seine and gill net samples was reduced by one-half in October, and these gears could not be used in November. Electrofishing was not possible along the dikes in November. The number of river sandbar habitat seine samples was also reduced in both October and November. Because effort could not be standardized by month, gear, habitat, or microhabitat, all comparisons are made on the basis of catch per unit of effort for numbers. Variation in weights per unit effort

were so large that analyses were not performed on this variable. Numbers of species collected cannot validly be compared per unit of effort. Total catches by month, gear, habitat, and microhabitat are presented in Appendix A.

65. Stack Island Pool. The total fish catch in this pool consisted of 3,648 individuals, weighing 422.5 kilograms (kg), and representing 43 species (Tables A1-A3). Numerically, over 73 percent of the catch was comprised of emerald shiners, threadfin shad, gizzard shad, and river shiners. By weight, the catch was dominated by smallmouth buffalo, gizzard shad, shortnose gar, common carp, and longnose gar. Monthly catches ranged from a low of only 186 fish in January to 1,965 fish in August. Weight was also lowest in January (36.7 kg), but was highest in October (116.7 kg). A low of 21 species was found in January, compared to 36 species taken in August.

66. Electroshocking catch per unit effort differed significantly among months in Stack Island Pool ($F = 6.8$; $P < 0.0001$), with August-September, October, and November-January forming significantly different groups (Table 9). Microhabitats also differed significantly ($F = 17.4$; $P < 0.0001$), with the pool sandbar, the natural bank plus the dike, and the midpool constituting the significantly different groups.

67. Gizzard shad dominated the electroshocker catches in most Stack Island Pool microhabitats during August and September (Table 10), the single exception being the dike microhabitat during September. Gizzard shad were significantly more abundant along the pool sandbar than along either the dike or natural bank ($F = 4.2$; $P < 0.05$) for these two months combined. Although no other species showed significant differences in abundance among the microhabitats (midpool microhabitat excepted, since catches were always zero there), flathead catfish, white bass, blue catfish, and blue sucker were most commonly collected along the dike. A large number of species were collected in moderate abundance during October and November (Table 10). The only species to show a significant difference in catch rate among microhabitats was river carpsucker in October, which was more abundant in the pool sandbar microhabitat ($F = 3.3$; $P < 0.05$). January catches were quite low (Table 10), and no species showed a significant preference for either microhabitat sampled.

68. Seining numerical catch per unit effort showed more variability among months than did electroshocking (Table 9). Mean catch was significantly different among months ($F = 15.1$; $P < 0.0001$), with August-October catches being

significantly higher than those in November and January. Seining catches were significantly higher along the pool sandbar than along the natural bank within this pool ($F = 9.2$; $P < 0.001$).

69. Eight to ten species were commonly collected by seine within Stack Island Pool (Table 11), and a number of these differed in abundance among months or microhabitats. Juvenile threadfin shad were significantly more abundant in August than in any other month ($F = 33.6$; $P < 0.0001$), and they were also significantly more abundant along the pool sandbar than along the natural bank ($F = 40.1$; $P < 0.0001$). Although collected in much lower overall numbers, juvenile river carpsucker showed a similar pattern, being significantly more numerous in August and September than in the following months ($F = 8.8$; $F < 0.01$), and being more numerous along the pool sandbar ($F = 19.4$; $P < 0.001$). Catch per seine haul of river shiner was highest in August, intermediate in January, and comparatively low from September-November ($F = 4.9$; $P < 0.05$).

70. Seasonal changes in species composition of seine collections were large. As noted above, threadfin shad and river carpsucker were taken only in August and September, and the number of river shiner fluctuated considerably, though this species was present in every month. Several species, including speckled chub, mimic shiner, bullhead minnow, and juvenile channel catfish, were only taken in abundance in October.

71. Due to the low number of samples and generally high variability, no significant differences in gill net catches were found among months ($F = 2.6$; $P > 0.125$). September and January catches were only about one-third to one-sixth those of the other months, however (Table 9).

72. Although several species were collected in low to moderate abundance in gill nets in Stack Island Pool (Table 12), only gizzard shad showed a significant difference among months. August catches were greater than those in all other months, and October catches were greater than all but August ($F = 4.9$; $P < 0.01$).

73. Ajax Bar Pool. Forty-four species were collected from Ajax Bar Pool during this study (Tables A4-A7). Nearly three-fourths of the 3,222 fish captured was made up of gizzard shad, threadfin shad, emerald shiner, river shiner, and silverband shiner. Four species, including gizzard shad, blue catfish, river carpsucker, and common carp, dominated by weight. Monthly catches varied from only 49 fish weighing 12.9 kg in November, to 1,503 fish

weighing 116.2 kg in August. The number of species collected was lowest in November and highest in October.

74. Mean numerical electroshocking catches per unit effort differed among months ($F = 22.5$, $P < 0.0001$), with August-September being significantly higher than the remaining months, and October also differing from January within the latter group (Table 9). Among the four microhabitats, dike catches were significantly higher than those along the pool sandbar and natural bank, and catches at these latter two were also significantly higher than in the midpool ($F = 14.3$; $P < 0.0001$).

75. Gizzard shad was the numerically dominant species collected by electroshocker in all Ajax Bar Pool microhabitats from August-October (Table 13). This species was significantly more abundant per unit effort in August and September than in the following months ($F = 11.5$; $P < 0.0001$); no significant differences in catch were noted among microhabitats, however. No other species showed significant differences among either months or microhabitats. White bass, blue catfish, flathead catfish, freshwater drum, and common carp were consistently present in the natural bank microhabitat (Table A5), but they were collected in only moderate to low abundance (Table 13).

76. Mean seining catch varied significantly among months ($F = 30.5$; $P < 0.0001$); August, September-October, and January were the significantly different groups (Table 9). No seine hauls could be taken in this pool in November. Differences among microhabitats were not significant ($F = 2.8$; $P > 0.05$).

77. A number of species were common in seine samples from Ajax Bar Pool during August, September, and October (Table 14), many of which displayed differences in catch rates either among months, microhabitats, or both. Catches of threadfin shad and river carpsucker juveniles were significantly different among months ($F = 27.9$; $P < 0.0001$; $F = 20.6$; $P < 0.0001$, respectively), with August catches being highest, September lower, and the remaining months very low or zero. These two species also demonstrated distinct microhabitat preferences; threadfin shad were significantly ($F = 13.4$; $P < 0.0001$) more abundant along the pool sandbar and the dike, while river carpsucker were common only along the pool sandbar ($F = 40.8$; $P < 0.0001$). Most species were most abundant in either August or September; silverband shiner, however, was significantly more abundant in October than in any other month ($F = 6.6$; $P < 0.01$).

78. Mean numerical catch per unit effort for gillnetting was significantly different among months ($F = 15.9$; $P < 0.0093$), with August-September being higher than October-January (Table 9). Gill net catches were not evaluated for differences among microhabitats due to very low sample numbers.

79. Gill net catches in Ajax Bar Pool were dominated by gizzard shad, although a number of other species were captured in low to moderate abundances (Table 12). Gizzard shad were significantly more abundant in August and September ($F = 22.7$; $P < 0.0001$) than in any other month; October catch was intermediate between August-September and January. Blue catfish was the only other species showing a significant difference in catch rates among months, with catches being higher in September and October than in August and January ($F = 5.0$; $P < 0.01$). Gill nets documented the presence of two species generally uncommon in collections, shovelnose sturgeon and sauger.

80. River sandbar. A total of 1,240 fish, weighing 37.8 kg, and including 30 species (Table A8), was collected from the river sandbar habitat. The numerical catch was lowest in January and highest in October; weight catch was highest in September and lowest in November; and, the number of species taken was lowest in January and highest in August. Nearly 75 percent of the catch was made up of just six species: river shiner, threadfin shad, speckled chub, emerald shiner, river carpsucker, and gizzard shad. Gizzard shad dominated by weight, along with blue catfish, smallmouth buffalo, channel catfish, and common carp.

81. Electroshocking catch per effort was significantly different among months ($F = 3.0$; $P < 0.05$). August-September differed significantly from November and January, with October bridging the two groups by statistically combining with both (Table 9).

82. Gizzard shad, threadfin shad, and blue catfish were the most common species collected by electroshocker in the river sandbar habitat (Table 15). Catches of gizzard shad and blue catfish were significantly higher in August and September than in the other three months ($F = 5.5$; $P < 0.05$; $F = 3.7$; $P < 0.05$, respectively). Catches of threadfin shad were greater in August than in other months ($F = 3.2$; $P < 0.05$). All other species were infrequently taken.

83. Seining catch increased from August-October, then declined through January (Table 9). Mean catch per effort differed significantly ($F = 12.6$; $P < 0.0001$), with August-October being higher than November-January.

84. Seine catches in the river sandbar habitat yielded up to 11 relatively abundant species in some months (Table 16), and many of these exhibited differences in abundance among the five months. Threadfin shad were significantly more abundant in August ($F = 16.8$; $P < 0.001$) than in other months, and their abundance in September and October was also greater than in November and January. Similarly, river carpsucker juveniles were more common in August through October than in the following two months ($F = 10.0$; $P < 0.001$). Emerald shiner and blacktail shiner abundances were higher in September, and river shiner abundance in September and October, than in other months ($F = 4.3$; $P < 0.05$; $F = 3.9$; $P < 0.05$; $F = 7.1$; $P < 0.01$, respectively). Speckled chub, silverband shiner, and juvenile channel catfish were all most abundant in October ($F = 9.2$; 4.3, and 5.9, respectively, all $P < 0.01$).

85. Comparisons among habitats. No substantial differences were noted between the overall fish assemblages of the two pools. In fact, species compositions of microhabitats within individual pools usually differed more than did the two pools themselves. Species composition of comparable microhabitats within the two pools (e.g., Stack Island Pool sandbar versus Ajax Bar Pool sandbar) was more similar than the species compositions of less similar microhabitats (e.g., Stack Island Pool sandbar versus Ajax Bar natural bank). Clearly, species distributions were determined principally by the precise type of microhabitats available within the general study area.

86. Electroshocking showed no significant numerical difference among the three habitats ($F = 1.88$; $P > 0.16$). Differences among months for all pooled habitats was significant ($F = 24.5$; $P < 0.0001$), with August-September catches far exceeding those in the three subsequent samplings. Differences among the four microhabitats within the pools, plus the river sandbar, indicated that the pool sandbar-dike-natural bank group had the highest catches, the river sandbar had intermediate catches, and the midpool had the lowest catches ($F = 14.88$; $P < 0.0001$).

87. Like electroshocking, seining showed no significant overall differences among Stack Island Pool, Ajax Bar Pool, or the river sandbar ($F = 1.59$; $P > 0.21$). Differences among months were again highly significant ($F = 45.54$; $P < 0.0001$); August catch per effort was highest, September-October intermediate, and November-January lowest. Microhabitat differences were significant ($F = 2.88$; $P < 0.0387$). Catches along the pool sandbar were highest, those

along the natural bank were next highest, and catches along the dike and river sandbar were marginally lower.

88. Gill net catches differed significantly between Stack Island and Ajax Bar pools overall ($F = 14.9$; $P < 0.002$), with Ajax Bar Pool yielding nearly 2.5 times as many fish per net-day. Overall differences were also found between months ($F = 6.1$; $P < 0.005$); August through November catches were significantly greater than those in January.

89. Rotenone collection. The number of fish killed during the rotenone collection was several times greater than had been anticipated. Even after one and one-half days of pick-up an estimated three-quarters of all fish still remained. In order to incorporate their numbers and biomass into the estimates, a subsampling procedure was devised. Collection baskets which held 65 pounds (lbs) of fish were used to remove the remaining fish from the water. The number of baskets of fish removed were counted, and the species compositions, numbers, and weights from all previously sorted baskets were used to estimate the composition, numbers, and weights of fish in the baskets. However, all larger individuals of species other than shad were removed when the baskets were taken to the shore for burial of the fish. In addition, all small fishes encountered during the first one and one-half days of pickup were preserved in formalin and identified in the lab. Due to the large number of small fish preserved, a 20-percent subsample was used to estimate species composition, numbers, and weights.

90. A total of 18 species were taken in the set (Table 17). Over 95 percent of the fish were either gizzard or threadfin shad, with threadfin shad dominating. A rather large number of young-of-year freshwater drum and river carpsucker were also captured. The total catch by weight consisted of over 3,088 kg, or nearly 3,398.5 pounds per acre (lb/ac). As with numbers, gizzard and threadfin accounted for nearly all of the weight. The catch of larger, predatory species was low compared to that of the shad. However, their biomass was somewhat more substantial when put on a per acre basis. Catfishes, for example, accounted for over 10 lb/ac.

Hydroacoustic surveys

91. Stack Island Pool. The mean density of fish in Stack Island Pool was high in August and much lower in November and January (Table 18). Mean fish densities varied from 0 to 763 fish per hectare in the different microhabitats sampled (see Figure 2). In all three months, mean data derived from transects

within individual microhabitats showed that densities were consistently highest along the natural bank, next highest in the plunge pool below the upstream dike, and lowest in the fast currents near the downstream dike. Cross-pool transects (Figure 9) also showed that fish were most concentrated along the natural bank, and numbers declined rapidly toward the midpool and the pool sandbar. In August about 55 percent of fish detected in the midpool microhabitat were within about 50 m of the natural bank. In the plunge pool, fish were most concentrated along the portion of the dike nearest to shore. This was the deepest part of the plunge pool, and it abutted the relatively quiet eddy microhabitat. Fish appeared to be most numerous in the transition zone between the eddy and the plunge pool.

92. Depth profiles suggested that in the plunge pool usually more than 80 percent of the fish were in the bottom half of the water column (Figure 10). In the midpool and along the natural bank, fish showed a more even distribution through the water column, although they tended to be somewhat more bottom-oriented with increasing depth.

93. Target strengths at Stack Island Pool (Figure 11) were analyzed only in the midpool microhabitat during August and January, acoustic noise or insufficient data precluding analysis in other microhabitats and in November. Estimated fish sizes ranged from -60 to -18 dB (2 to 271 centimetres (cm)) in August, and from -60 to -30 dB (2 to 64 cm) in January, with a median size of -48 dB (7 cm) in August and -46 dB (9 cm) in January. Targets larger than -30 dB (64 cm) were rare. The largest targets, between -28 and -18 dB (84 to 271 cm), may have been measured from echos returned from submerged trees rather than fish. Fish size distribution was similar in both months with fish being about equally abundant in the range of common sizes between -54 and -36 dB (4 to 31 cm).

94. Ajax Bar Pool. Mean fish densities varied considerably among both microhabitats and months in this pool (Table 18). In midpool, mean fish density was high in August and low in November and January. In contrast densities along the upstream dike, along the natural bank, and in the eddy (scour hole) were relatively high at all river stages. Densities along the dike were highest in November, when the submerged dike afforded protection from swift water currents. Fish were more abundant in the deeper portions of the pool during the low-water periods in August and January. Thus, they were more

concentrated near the natural bank than near the pool sandbar, and more concentrated near the upstream dike than near the downstream dike (Figure 12).

95. Depth profiles in Ajax Bar Pool showed no clear trends (Figure 13). In the shallowest waters of the midpool microhabitat, fish were found at all depths. In the deeper waters near the upstream dike, fish were seldom found near the surface, but were evenly distributed throughout the lower two-thirds of the water column. The only exception to this pattern was in the eddy in November when more than half the fish were detected in the upper 2 m of the water column.

96. Target strength analysis showed fish ranging in size from -60 dB to -36 dB (2 to 31 cm) during August (Figure 14). Median target size was similar in all microhabitats. No target strengths measurements were available in November, and they were available in January only for the upstream dike. Target strengths here ranged from -60 to -36 dB (2 to 31 cm) with a median size of -50 dB (6 cm). Median target size and the range of target sizes were similar in the dike microhabitat during both August and January.

97. Comparison of habitats. There were several congruent patterns of fish distribution in the two pools. Densities of fish in the midpool microhabitat were similar at both Stack Island and Ajax Bar pools in all months (Table 18). Fish were widely distributed throughout both pools (Figures 9 and 12), but highest fish densities in both pools occurred along the natural banks, densities reaching 763 fish per hectare in this microhabitat at Stack Island Pool in August and 416 fish per hectare in Ajax Bar Pool in November. The upstream dike in both pools created two kinds of microhabitats used by fish: a plunge pool and an eddy near the natural bank just downstream of the dike. Fish used these areas in all months, but they were relatively more important during high water, when both eddy and dike were probably used by fish for protection from swift currents. Target strength distributions were variable in both pools (Figures 11 and 14), commonly ranging between the lower processing threshold of -60 and -30 dB (2 to 64 cm). Median target strengths were also similar, -50 to -46 dB (6 to 9 cm).

PART IV: DISCUSSION

98. Dike pool habitat is defined hydrologically as existing in Lower Mississippi River dike fields only below +15 ft LWRP (Cobb and Magoun 1985). The +15-ft elevation is used as the upper water surface boundary of dike system aquatic habitat because flowing water conditions typically become dominant above this stage, and the shift from slackwater to pronounced flowing water conditions marks a fundamental change in the ecological properties of the aquatic habitat. During the low-flow period (July-December), river stage is ≤ +15 ft LWRP 76.7 percent of the time (141.2 days), with an average of two low-water (< +15 ft) events per year, each lasting about 68 days (Cobb and Magoun 1985, Table 10). The average event duration for higher flows (> +15 ft) is 21 days during the low-water period.

99. Cobb and Magoun (1985) also placed a lower river stage limit (0 ft LWRP) for dike system pool habitat. Stages are within the 0- to +15-ft interval 125 days per year on the average. The average event duration is only 33 days, with an average of 3.8 events per year (Cobb and Magoun 1985, Table 10). This is presumably the reason that Cobb and Magoun consider dike pool habitat to be ephemeral, or unstable. However, the most important ecological change is that from slack-water to flowing water conditions (i.e., below or above +15 ft). Although both the surface area and volume of dike pool aquatic habitat decline with decreasing stage, this habitat does not undergo a fundamental ecological change at 0 ft LWRP like that observed at stages > +15 ft (i.e., it does not go to "zero"). In the two study pools, for example, a rather large amount of aquatic habitat is still available below 0 ft, 216 and 71 acres in Stack Island and Ajax Bar pools, respectively (Cobb and Magoun 1985, Tables B26 and B28).

100. Using the less restrictive view of the two noted above, dike pool habitat does not appear to be so ephemeral. If, during the low-water season, slackwater habitat is available (on the average) for 77 days at a time, most species which use such environments for spawning and nursery areas would probably find this a sufficient amount of time for the young to reach a size at which they could contend with the brief changes to flowing water conditions. Additionally, the Cobb and Magoun (1985) study considered the entire low-water period (July-December) as a unit. It is possible, however, that river stage remains below +15 ft longer during some segments of this period (e.g.,

August-October) than others (e.g., July and November-December). Since the highest densities of juvenile fishes are present during August and September, they may typically find pooled conditions available for even longer than the 77 day average.

101. The general nature of the sediment, limnological characteristics, primary production, and the structures of the macroinvertebrate and fish communities in dike field pools all depend to a great degree upon the amount of inflow. For any particular dike pool, the amount of inflow is determined by river stage and the controlling elevation of the upstream dike and the surrounding bottom. As shown in this study, the variation among pools, even within the same river reach and at the same river stage, may be considerable.

102. When a significant amount of inflow enters the pool, the limnological characteristics of the water reflect those of the main channel (Sabol, Winfield, and Toczydlowski 1984; Beckett and Pennington 1986). When a pool becomes slack, however, substantial changes occur. Turbidity decreases markedly, and the resultant increased photic zone promotes primary production. In this study, chlorophyll concentrations, and estimates of primary production, were higher in Ajax Bar Pool (slack-water conditions during August and September) than in either Stack Island Pool or the river sandbar habitat. Productivity estimates for Ajax Bar Pool did not reach those found in Lake Providence Harbor or the borrow pit; however, most other studies have determined that lentic habitats off the main channel account for most of the system's primary production (Modde and Schmulbach 1973; Patrick 1975; Beckett et al. 1983; Benke, Van Arsdall and Gillespie 1984). However, it appears that many dike pools can contribute substantially to the primary productivity of river ecosystems during at least parts of most years.

103. The prevailing weather may have a modifying effect on limnological conditions within dike pools through solar heating or wind-generated mixing. Water temperature and wind-generated mixing probably largely determine, for example, the DO concentrations found at any given depth within a slackwater pool.

104. The water depth, at a given river stage, appears to generally determine whether or not stratification will occur in slack-water pools. Deep pools are less susceptible to wind-generated mixing, and the bottom water may be considerably cooler than that found in shallower areas. However, long-term stratification almost certainly results in oxygen depletion and severe

reducing conditions in lower strata. In this study Ajax Bar Pool showed some stratification and oxygen depletion during September. The open pool, Stack Island Pool, never indicated any tendency toward stratification.

105. Dikes, by controlling inflow into their pools, also control to some extent the overall sediment grain-size distribution. At all seasons, Ajax Bar Pool had finer sediments than did Stack Island Pool, a difference directly related to the relative current velocities within these pools. The upstream dike at Ajax Bar Pool had higher crown elevations for comparable distances from the bankhead than did the upstream dike at Stack Island Pool. In addition, the dike at Stack Island Pool allowed more inflow through the pool around the channelward end of the dike. Lower current speeds during more of the year allow finer sediments to accumulate in Ajax Bar Pool; accumulations of finer sediments in Stack Island Pool were limited primarily to slower current areas adjacent to the pool sandbar, to the eddy area near the natural bank end of the dike, and to small areas along the natural bank. Ajax Bar Pool sediments were primarily fine sand and silt-clay during August-September, less than three months after the spring-early summer high-water season. After the November-December high river stage, somewhat coarser sediments (fine and medium sand) predominated in this pool. This suggests that in dike pools such as Ajax Bar, sediment grain-size distribution follows a seasonal pattern; high water periods scour much of the fine sand and silt-clay, which then rapidly reaccumulate at lower river stages.

106. The macroinvertebrate and fish populations of flowing water systems respond primarily to microhabitat conditions, including current speed, substrate type, temperature, DO, and turbidity, among others. Whether the appropriate conditions for any given species are provided by a revetment, by a natural sandbar, or by a dike is unimportant; it is the immediate physical-chemical surrounding which is important to the organism. River training activities, dikes in this study, merely alter the spatial arrangement, and perhaps the relative proportions, of habitats within the river as a whole.

107. The relatively large number of taxa of fish and macroinvertebrates collected in this study is typical of dike pools (Pennington et al. 1980; Burgess, Krieger, and Pennington 1982; Beckett et al. 1983; Pennington, Baker, and Bond 1983; Beckett and Pennington 1986). This species richness reflects the fact that dike pools, for the most part, provide a diverse mixture of microhabitats (i.e., pool sandbars, dike plunge pools, eddies, natural

banks, and large expanses of open water) having a wide variety of physical-chemical conditions (Cobb and Clark 1981). It is not unusual to find all these microhabitats within a single dike pool, and within an entire dike system each type may be represented many times.

108. The taxa of macroinvertebrates, their relative abundances, and their relationship to observed physical features, particularly sediment grain size, correspond with those of previous studies (Mathis et al. 1981; Beckett et al. 1983; Benke, Van Arsdall, and Gillespie 1984; Sanders et al 1985; Baker et al. 1987a). The benthos found at Ajax Bar Pool generally reflected a fine-substrate, slow-current environment during all sampling periods. The macroinvertebrates of Stack Island were similar to those of Ajax Bar from August through early November; however, the benthic assemblage changed dramatically following the river stage rise during mid-November through December, and this change in the benthic macroinvertebrate populations appeared to be related to changes in sediment grain size. The Chironomidae illustrated this change particularly well. Prior to the rise, taxa such as Cryptochironomus, Chironomus, Ablabesmyia, and Harnisha dominated. Following the rise, the chironomids found in Stack Island were primarily Chernovskiia orbicus and Robackia claviger, species known to prefer rather swift, coarse-substrate habitats (Beckett et al. 1983). Although the genera found in Ajax Bar Pool also changed somewhat, the predominant forms remained slack-water, fine-substrate types.

109. The macroinvertebrate fauna found during our single August dike collection was typical of that noted in other studies (Mathis et al. 1981; Mathis, Bingham, and Sanders 1982; Beckett et al. 1983; Sanders et al. 1985), and also similar to the faunas found on snags (Benke, Van Arsdall, and Gillespie 1984; Baker et al. 1987b). Caddisflies dominated, particularly the species Hydropsyche orris, and several chironomids in the genus Polypedilum, along with the mayfly Stenonema integrum were also prominent. As long as current flows either over or along the dikes, these organisms appear to be abundant, and their probable high production rates (Benke, Van Arsdall, and Gillespie 1984) make it likely that they contribute substantially to the energy web of the river ecosystem.

110. Gatherers and deposit feeders dominate sandy and muddy substrates, respectively, of larger rivers (Benke, Van Arsdall, and Gillespie 1984;

Beckett et al. 1983). Filterer organisms tend to dominate on hard substrates such as rocks and snags. Predators occur at low abundances in all habitats. These distributions were observed within the study pools at all river stages.

111. The wide variety of species of fish collected and the tremendous size range observed within individual species substantiate earlier assertions that dike pools provide suitable habitat for all life history stages of many species of fish (Pennington et al. 1980; Burress, Krieger, and Pennington 1982; Conner, Pennington, and Bosley 1983; Pennington, Baker, and Bond 1983). In August and September, particularly, large numbers of young-of-year fish were collected by seine along the pool sandbar. The most common species were "forage" types, such as gizzard and threadfin shad, minnows, and river carpsuckers. However, young-of-year fish of many predator species, including white bass, channel and blue catfishes, and freshwater drum, were also common in this and other dike pool habitats.

112. Hydroacoustics and traditional fish collecting methods gave different estimates of fish abundance in the various microhabitats. However, they do not sample microhabitats with equal accuracy, and their results should be viewed as complementary. Hydroacoustics indicated that the plunge pool and eddy area at Stack Island Pool held large numbers of mostly bottom-oriented fish. The depth, swift currents, and turbulence made these areas very difficult to sample with electroshockers or nets, and as a result these gears gave relatively low abundance estimates. In Ajax Bar Pool, where both types of sampling could be accomplished successfully at several times, both gears indicated high densities of fish near the dikes. Hydroacoustics also showed that, when conditions were favorable (low river stages), a rather large number of fish utilized the midpool areas. Both gear types indicated substantial numbers of fish along the natural bank; however, only traditional gears correctly assessed the abundance of fish along the relatively shallow pool sandbar. On the whole, it appears that all microhabitats within dike pools are heavily utilized during pooled conditions.

113. Use of the open, midpool microhabitat by fish was variable, and it appeared to be a function of both river stage and season (water temperature). Densities of fish were high in August and low in November and January. In August, river stage was relatively low, the water was warm, and large numbers of fish were present. Low November use was probably due to the high river stage, which caused swift currents in the midpool microhabitat. Low use

during January may have been due to a combination of cold water temperatures (causing fish to be inactive) and an inadequate time for recolonization following the November-December high-water period. This conclusion was substantiated by the low electroshocking and seining catches in the Ajax Bar Pool sandbar microhabitat in January. Fish inhabiting this area during low water were undoubtedly forced to move to other microhabitats (typical sandbar species were found in shallow, flooded areas along the natural bank at this time) by the swift currents crossing the area in November-December. As with the midpool microhabitat, recolonization of such areas is probably slow at cold water temperatures.

114. In addition to the apparent movement of fish out of the swift, midpool habitat during high flows, hydroacoustics also indicated that even at lower stages fish in Stack Island Pool were distributed most densely near the natural bank. Abundance declined rapidly with distance from the natural bank, and fish became more bottom-oriented. This distribution was very similar to that observed along both revetted and natural banks in the Lower Mississippi River by Baker et al. (1987a). This presumably is a behavioral response enabling fish to avoid the swiftest currents, as current velocity typically is reduced both near shore and near the bottom in rivers (Leopold, Wolman, and Miller 1964).

115. It is probable that the use of dike pools by larger individuals of predatory fish species is underestimated by our methods of sampling. Our data indicated, for example, that relatively few white bass and catfish inhabited either pool. However, personal observations made on numerous trips to the study area suggest that these species utilize the pools intermittently, possibly moving frequently between pools, and between pools and the adjacent main channel sandbar area. Conversations with commercial fishermen and sportfishermen utilizing the study area support the probability that pool use by predatory species is sporadic.

116. It is also possible that use of dike pools by predatory species is a function of some aspect not evaluated in this study. One plausible hypothesis is that predatory species move rapidly among pools in search of schools of prey of the proper size. Another is that use of the pools is primarily concentrated near dusk and dawn or is even primarily at night during the warmer months. These hypotheses are given support by an unpublished study, performed by the first author of this report, in which gill nets were used to partially

block off the entrance to a slack-water dike pool. Over a 36-hr period, considerable differences were observed in terms of the times of entry and exit of several predatory species. Catfishes entered the pool in rather large numbers early in the evening, and they exited just before dawn. White and striped bass tended to show the opposite pattern, although more variability was observed for these species.

PART V: CONCLUSIONS

117. The two study pools illustrate the extremes along the continuum of dike pool physical types found in the Lower Mississippi River. There is considerable inflow of main channel water into Stack Island Pool even at relatively low river stages. In contrast, the upstream dike at Ajax Bar Pool nearly eliminates inflow at lower stages. These differences cause the physical-chemical makeup of the pools to diverge at lower river stages.

118. At high river stages, water quality, nutrient levels, and primary productivity within the two study dike pools are indistinguishable from that of the main channel. Current speeds (higher) and sediments (coarser) also resemble those of the main channel. Stack Island Pool had appreciable flow even at the lowest observed river stage and thus generally resembled the main channel at all times. Ajax Bar Pool isolates at stages below about 12 ft LWRP, and at these times water quality, nutrient levels, primary production, current speed, and sediment conditions resemble other slack-water habitats more closely. Levels of primary productivity, while potentially high in pools isolated for fairly long periods, probably cannot match that of habitats (oxbow lakes, abandoned channels, borrow pits) which are slack for the majority of the time.

119. Macroinvertebrates collected on the dikes and in the sediments were typical of those taken in earlier studies in the Lower Mississippi River. As noted in the earlier studies, and as indicated by this study, current speed and substrate characteristics probably determine the macroinvertebrate assemblage found at any particular site. No significant difference in densities of macroinvertebrates was observed between the two pools. However, densities in Ajax Bar Pool (finer sediments) were typically much larger than those in Stack Island Pool, and the lack of statistical significance was likely due to insufficient numbers of samples.

120. Fish assemblages did not differ appreciably between the two pools; a somewhat larger difference was observed between the two pools and the adjacent river sandbar habitat. Estimated densities of fish were not different between the two pools and the river sandbar. Microhabitats within pools (pool sandbar, dike, natural bank, midpool) did differ in both density and species composition. Differences attributable to season were statistically significant,

with catches in August and September generally exceeding those in October through January.

121. Dike pools provide habitat for a wide range of species and life history stages of fish. Their value as nursery areas for larval and juvenile fish, and as feeding areas for larger individuals, is very high. However, dike pools are not optimal habitats for all species of fish in the river ecosystem, particularly those which prefer areas which are slack during most or all of the year.

122. Hydroacoustics allowed a more complete examination of fish use of deep, swift habitats than has been previously possible with traditional fish collecting gears. Fish use of the dike plunge pool, eddies, and the natural bank microhabitats was shown to be relatively high. Use of the midpool habitat was also shown to be substantial at low river stages, but much less at high stages.

123. The distribution of fish at high river stages was found to be shoreline and bottom oriented. Use of near-shore and near-bottom areas presumably enables fish to avoid the swift currents found in more open areas. This distribution parallels that along the natural and revetted banks.

124. Use of dike pools by larger, predatory species is probably underestimated by present sampling. Available evidence, though scarce, suggests that such species may move frequently between pools, and between pools and the adjacent river sandbar habitat. Therefore, sampling performed over a very short period at any given time may fail to detect this pattern.

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Table 1

Dike System Engineering Characteristics and Habitat Physical Characteristics for Stack Island Pool, Ajax Bar Pool, and the River Sandbar*

Dike	River Mile	Dike Length (ft)	Date Built	Dike Crest Elevation (LWRP, ft) 0%	25%	50%	75%	100%
Stack Island:								
upstream	491.4	2020	1964	18.0	13.0	11.0	8.0	11.0
downstream	488.6	4135	1969	26.0	20.0	16.0	14.0	12.0
Ajax Bar:								
upstream	484.4	1840	1968	29.0	24.0	18.0	12.0	8.0
downstream	483.6	2905	1968	37.0	30.0	12.0	3.0	-4.0

Habitat	LWRP (ft)	Total Surface (Acres)	Volume (cu yd)	Depth (ft)
Stack Island Pool	≤ 0	216	5.389E+06	15.5
	≤ 5	248	7.260E+06	18.1
	≤ 10	280	9.390E+06	20.8
	≤ 15	307	1.176E+07	23.7
River sandbar**	≤ 0	285	1.074E+07	23.4
	≤ 5	318	1.320E+07	25.8
	≤ 10	350	1.589E+07	28.2
	≤ 15	361	1.876E+07	32.3
Ajax Bar Pool	≤ 0	147	2.057E+06	8.7
	≤ 5	257	3.686E+06	8.9
	≤ 10	367	6.203E+06	10.5
	≤ 15	409	9.333E+06	14.1
River sandbar**	≤ 0	88	9.525E+05	6.7
	≤ 5	101	1.713E+06	10.5
	≤ 10	115	2.584E+06	14.0
	≤ 15	118	2.864E+06	18.5

* Data adapted from Cobb and Magoun (1985).

** Data presented in Cobb and Magoun (1985) for total sandbar habitat is not broken out by pool. Data in the above table were estimated for the sandbar habitat bordering only the two study pools by multiplying Cobb and Magoun's figures by the percentage each pool's length comprised of the total length of each of the two included dike systems (Baleshed Landing and Ajax Bar).

Table 2

Summary of Water Quality Parameters and Nutrient Analysis for the Productivity Study, August and September 1986*

Date	Location**	Water Quality Parameters: Temperature (°C)	Dissolved Oxygen (mg/ℓ)	pH	Conductivity (μmhos/cm)	Oxidation-Reduction (mV)
4 Aug	DFY	29.9 (29.8-30.0)	5.8 (5.5-6.1)	7.4 (7.4-7.5)	447 (444-450)	245 (233-251)
4 Aug	LP	30.2 (29.7-31.1)	4.4 (2.4-7.0)	6.8 (6.5-7.0)	438 (422-446)	247 (201-265)
5 Aug	DFX	29.9 (29.7-30.5)	6.0 (5.8-6.0)	7.3 (7.2-7.4)	444 (441-448)	239 (234-245)
5 Aug	RS	29.9 (29.7-30.7)	6.4 (6.3-6.5)	7.3 (7.0-7.4)	444 (436-453)	238 (233-243)
6 Aug	BP	26.5 (15.0-30.9)	3.7 (1.2-7.7)	7.3 (6.6-8.2)	336 (312-408)	3.7 (-130-211)
18 Sept	DFY	25.5 (25.2-26.3)	6.0 (3.2-9.3)	7.5 (7.2-8.1)	481 (454-483)	198 (125-252)
18 Sept	LP	27.8 (27.6-27.9)	5.1 (4.5-6.3)	6.8 (6.7-6.8)	579 (578-580)	257 (250-267)
17 Sept	DFX	25.5 (25.2-25.8)	7.1 (6.8-7.3)	7.2 (6.6-7.5)	452 (443-457)	266 (253-296)
17 Sept	RS	25.8 (25.4-27.0)	7.4 (7.2-7.5)	7.6 (7.5-7.6)	459 (457-459)	250 (244-256)
10 Sept	BP	24.6 (15.8-28.8)	3.7 (1.6-6.8)	6.9 (5.9-7.7)	338 (309-430)	-28.5 (-104-114)

(Continued)

* Values presented as means, with ranges below in parentheses.

** DFY = Ajax Bar Pool; LP = Lake Providence harbor; DFX = Stack Island Pool; RS = river sandbar; BP = borrow pit.

Table 2 (Concluded)

Date	Location	Nutrients, mg/ℓ Total Phosphorus	Nitrate/Nitrite	Ammonia	TKN
4 Aug	DFY	0.26	1.90/<0.010	<0.010	0.70
		(0.21-0.32)	(1.50-1.97)/(<0.010-0.040)	(*)	(0.62-0.78)
4 Aug	LP	0.20	1.09/0.031	0.012	0.83
		(0.13-0.28)	(0.887-1.97)/(<0.010-0.67)	(<0.010-0.016)	(0.58-1.0)
5 Aug	DFX	0.26	1.95/<0.010	<0.010	0.73
		(0.18-0.34)	(1.91-1.97)/(*)	(*)	(0.62-0.81)
5 Aug	RS	0.25	1.95/<0.010	0.009	0.84
		(0.18-0.34)	(1.88-1.97)/(*)	(<0.010-0.032)	(0.80-0.89)
6 Aug	BP	0.26	0.01/<0.010	0.401	1.17
		(<0.10-1.03)	(<0.010-0.014)/(*)	(<0.010-2.07)	(0.58-3.52)
18 Sept	DFY	0.18	0.42/<0.010	0.125	0.45
		(0.12-0.24)	(0.022-0.592)/(*)	(<0.010-0.848)	(0.16-0.99)
18 Sept	LP	0.34	0.19/<0.010	0.261	2.31
		(0.18-0.51)	(0.15-0.210/(*)	(0.233-0.307)	(0.53-3.66)
17 Sept	DFX	0.19	0.67/<0.010	0.007	0.42
		(0.12-0.25)	(0.640-0.695)/(*)	(<0.010-0.017)	(0.18-0.54)
17 Sept	RS	0.20	0.67/<0.010	0.011	0.51
		(0.16-0.25)	(0.645-0.714/(*)	(<0.010-0.027)	(0.42-0.56)
10 Sept	BP	0.24	0.02/<0.010	0.341	0.85
		(<0.10-1.25)	(0.012-0.020/(*)	(0.021-2.570)	(0.40-3.22)

* All values at or below detection limits.

Table 3

Means and Ranges for Dissolved, Suspended and Total Solids, and Total Organic Carbon (mg/ℓ) for the Productivity Study, August-September 1986

Date	Location*	Dissolved Solids	Suspended Solids	Total Solids	Total Organic Carbon
4 Aug 86	DFY	310 (302-319)	125 (23-158)	435 (339-467)	127 (114-135)
4 Aug 86	LP	314 (289-328)	27 (21-29)	341 (313-352)	125 (115-136)
5 Aug 86	DFX	330 (309-436)	104 (60-138)	434 (373-533)	129 (112-140)
5 Aug 86	RS	318 (308-327)	150 (123-165)	468 (438-491)	133 (123-149)
6 Aug 86	BP	258 (185-677)	25 (9-50)	283 (209-727)	117 (70-463)
18 Sept 86	DFY	356 (335-404)	27 (16-39)	383 (354-420)	111 (83-138)
18 Sept 86	LP	366 (344-414)	39 (35-56)	405 (379-450)	128 (108-151)
17 Sept 86	DFX	314 (291-340)	34 (14-62)	348 (318-384)	100 (80-146)
17 Sept 86	RS	309 (292-345)	133 (63-655)	442 (351-957)	147 (80-656)
10 Sept 86	BP	223 (202-252)	17 (6-45)	240 (209-296)	61 (45-83)

* DRY = Ajax Bar Pool; LP = Lake Providence Harbor; DFX = Stack Island Pool; RS = river sandbar; BP = borrow pit.

Table 4

Estimates of In Situ Photosynthesis at Different Depths and Light Penetration

Date	Location*	Light (%)	Depth (in.)	Dissolved** Oxygen (mg/ℓ) I.B.	L.B.	D.B.	Photosynthesis ($mg\ C/m^3/hr$) Net	Gross	Photosynthesis/Site ($mg\ C/m^3/hr$) Net	Gross
4 Aug 86	LP	80	4	8.2	11.2	7.0	1,250	1,750	1,375	3,666.7
		50	9	8.6	11.6	7.3	1,250	1,791.7		
		0	18	7.4	4.7	4.4	-1,125	125		
4 Aug 86	DFY	80	8	7.4	7.4	6.9	0	208	208.4	416.3
		50	12	7.2	7.3	7.1	41.7	83.3		
		0	18	7.0	7.4	7.1	166.7	125		
5 Aug 86	DFX	80	8	8.4	7.4	7.2	-416.7	83.3	-1,583.3	83.3
		50	15	8.6	6.9	6.8	-708.3	41.7		
		0	20	8.0	6.9	7.0	-458.3	-41.7		
5 Aug 86	RS	80	4	7.6	7.0	6.7	-250	125	-666.6	125
		50	8	7.5	7.0	6.8	-208.3	83.3		
		0	14	7.3	6.8	7.0	-208.3	-83.3		
6 Aug 86	BP	80	6	7.5	8.1	7.5	250	250	500	541.7
		50	28	7.9	8.5	7.8	250	291.7		
		0	60	0.0	0.0	0.0	0	0		
10 Sept 86	BP	80	2	7.3	6.9	6.6	-166.7	125	208.3	541.7
		50	5	6.6	7.1	6.4	208.3	291.7		
		0	17	6.0	6.4	6.1	166.7	125		
17 Sept 86	DFX	80	3	8.2	8.7	7.3	583.3	208.3	916.6	1,458.3
		50	9	6.2	9.1	8.5	250	1,208.3		
		0	44	7.6	7.5	7.3	83.3	41.7		
17 Sept 86	RS	80	2	8.2	9.1	8.1	375	416.7	833.3	958.3
		50	5	8.2	9.3	8.2	458.3	458.3		
		0	20	8.2	8.2	8.0	0	83.3		
18 Sept 86	DFY	80	2	8.2	11.2	9.9	1,250	541.7	2,958.3	4,487.3
		50	8	9.3	13.2	12.7	1,625	208.3		
		0	46	4.7	4.9	5.3	83.3	-166.7		
18 Sept 86	LP	80	2	7.8	17.7	8.7	4,125	3,750	8,583.3	8,916.7
		50	5	7.5	17.7	6.9	4,250	4,500		
		0	17	7.2	7.7	6.1	208.3	666.7		

* DFY = Ajax Bar Pool; LP = Lake Providence Harbor; DFX = Stack Island Pool; RS = river sandbar; BP = borrow pit.

** I.B. = Initial Bottle, initial dissolved oxygen concentration for each depth; L.B. = Light Bottle, dissolved oxygen concentration in the light bottles after incubation; D.B. = Dark Bottle, dissolved oxygen concentration in the dark bottles after incubation.

Table 5

Percent of Dominant Macroinvertebrate Taxa Collected from Stack Island and Ajax Bar Pools

Stack Island Pool: Sediments

August Taxon	%	November Taxon	%	January Taxon	%
Oligochaeta	53	Oligochaeta	41	Chironomidae	68
Tubificidae, n.c.	24	Tubificidae, n.c.	31	*C. orbicus*	32
L. maumeensis	21	*L. maumeensis*	6	*R. claviger*	29
L. cervix	5	Trichoptera	13	Oligochaeta	10
Ephemeroptera	18	*H. orris*	9	Tubificidae, n.c.	10
S. integrum	15	Chironomidae	20	Copepoda	16
Pelecypoda	5	*Cryptochironomus*	8		
Chironomidae	20	*A. annulata*	4		
H. curtilamellata	8	Ephemeroptera	19		
		Hexagenia	19		
		Copepoda	4		

Stack Island Pool: Dikes

August Taxon	%
Trichoptera	61
H. orris	48
Chironomidae	19
P. convictum	10
P. illinoense	4
Ephemoptera	19
S. integrum	14

(Continued)

Table 5 (Concluded)

Ajax Bar Pool: Sediments					
August		November		January	
Taxon	%	Taxon	%	Taxon	%
Oligochaeta	46	Oligochaeta	54	Chironomidae	36
Tubificidae, n.c.	30	Tubificidae, n.c.	46	*Cryptochironomus*	12
L. maumeensis	8	Chironomidae	23	*Coelotanypus*	7
Ephemeroptera	28	*A. annulata*	10	*Goeldichironomus*	4
Hexagenia	21	*Cryptochironomus*	5	*Procladius*	4
Pelecypoda	4	Trichoptera	13	Oligochaeta	29
Chironomidae	17	Hydropsychidae	8	Tubificidae, n.c.	16
Chironomus	5	*H. orris*	5	Ephemeroptera	10
		Gastropoda	5	*Hexagenia*	10
				Trichoptera	7
				H. orris	7

Table 6

Macroinvertebrate Densities Found in Stack Island Pool

Taxon	August Dike	August Sediment	November	January	Functional Group*
Diptera					
Culicidae					
Chaoborus punctipennis				24	P
Helicidae					
Bezzia sp.			49	24	P
Chironomidae					
Chironominae					
Axarus sp.					P
Chernovskiia orbicus				243	G
Chironomus sp.2		24			G
Cryptochironomus sp.	1	49	170		G,P
Dicrotendipes neomodestus	8				G
Glyptotendipes sp.	21				G,F
Goeldichironomus sp.			24		G
Harnisha curtilamellata	1	121	24		G,P
Lipiniella scopula					G
Parachironomus frequens	10				G,P
Paratendipes exquisita	1	24			G
Polypedilum convictum	185	49			F,P
P. halterale	3				F,P
P. illinoense	77				F,P
Rheotanytarsus sp.	13	24			F
Robackia claviger			24	219	G
Tanytarsus sp.2					F
Tanypodiinae					
Ablabesmyia annulata			73		G,P
A. mallochi	3				G,P
A. parajanta	20				G,P
Coelotanypus sp.		24	49		P
Procladius sp.					P,G
Tanypus stellatus					P
Thienemannimyia sp.					P
Orthocladinae					
Nanocladius distinctus	14				D
Thienemanniella sp.	7				G
Trichoptera	166				F
Hydropsychidae	23			49	F
Hydropsyche orris	927		194	219	F
Potamyia flava	59	49	24		F
Hydroptilidae					

(Continued)

* G = collector-gatherer; F = collector-filterer; D = collector-deposit feeder; P = predator; S = scraper; SH = shredder; SC = scavenger.

(Sheet 1 of 3)

Table 6 (Continued)

Taxon	August Dike	August Sediment	November	January	Functional Group
Neotrichia sp.		24			S
Polycentropodidae					
Neureclipsis crepuscularis	4				F
Ephemeroptera					
Baetidae					
Baetis sp.	20				G,S
Ephemeridae					
Hexagenia sp.		242	388	24	G
Pentagenia vittigera	1	49			G
Heptageniidae	72				G
Stenonema integrum	266				G,S
Tricorythidae					
Tricorythodes sp.	1				G
Odonata					
Gomphidae					
Dromogomphus sp.			24		P
Turbellaria					
Tricladida					
Dugesia tigrina	11				S
Hemiptera					P
Plecoptera					P,SH,G
Copepoda			24	121	S,F
Cladocera					
Daphnidae					
Daphnia sp.					F
Arachnida					P
Gastropoda	1				S,SC
Pelecypoda		73			F
Corbiculidae					
Corbicula fluminea			49	24	F
Amphipoda					
Corophidae					
Corophium lacustre	3		73		C
Gammaridae					
Gammarus sp.					SC
Isopoda					
Asellidae					
Lirceus sp.					SC
Annelida					
Oligochaeta					
Enchytraeidae					D
Tubificidae					D

(Continued)

(Sheet 2 of 3)

Table 6 (Concluded)

Taxon	August Dike	August Sediment	November	January	Functional Group
Aulodrilus piqueti					D
Branchiura sowerbyi					D
Limnodrilus cervix		73			D
L. hoffmeisteri		49			D
L. maumeensis		340	121		D
L. udekemeanus					D
Tubificidae, n.c. *		388	655	73	D
Tubificidae, c. *				121	D
Naididae					
Nais communis			49		D
N. pardalis	1				D
N. sp.	1				D
Total Density (no./sq m)	1,920	178	229	84	
SD of Density		191	324	60	
Number of Taxa	29	16	9	8	

* n.c. indicates tubificid immatures lacking capilliform chaetae; c. indicates tubificid immatures with capilliform chaetae.

(Sheet 3 of 3)

Table 7

Macroinvertebrate Densities Found in Ajax Bar Pool

Taxon	August	November	January	Functional Group*
Diptera				
Culicidae				
Chaoborus punctipennis	49		97	P
Helicidae				
Bezzia sp.	24		121	P
Chironomidae				
Chironominae				
Axarus sp.	49			P
Chernovskiia orbicus			24	G
Chironomus sp.2	121		49	G
Cryptochironomus sp.	24	49	389	G,P
Dicrotendipes neomodestus			49	G
Glyptotendipes sp.			24	G,F
Goeldichironomus sp.			121	G
Harnisha curtilamellata				G,P
Lipiniella scopula	49			G
Parachironomus frequens				G,P
Paratendipes exquisita	24	24		G
Polypedilum convictum	24			F,P
P. halterale				F,P
P. illinoense				F,P
Rheotanytarsus sp.		24		F
Robackia claviger			24	G
Tanytarsus sp.2	24			F
Tanypodiinae				
Ablabesmyia annulata	73	97	73	G,P
A. mallochi				G,P
A. parajanta			24	G,P
Coelotanypus sp.			219	P
Procladius sp.	49		121	P,G
Tanypus stellatus	97	24		P
Thienemannimyia sp.	24			P
Orthocladinae				
Nanocladius distinctus				D
Thienemanniella sp.				G
Trichoptera				
Hydropsychidae		73		F
Hydropsyche orris		49	219	F
Potamyia flava				F
Hydroptilidae				
Neotrichia sp.				S

(Continued)

* G = collector-gatherer; F = collector-filterer; D = collector-deposit feeder; P = predator; S = scraper; SH = shredder; SC = scavenger.

Table 7 (Continued)

Taxon	August	November	January	Functional Group
Polycentropodidae				
Neureclipsis crepuscularis				F
Ephemeroptera				
Baetidae				
Baetis sp.				G,S
Ephemeridae				
Hexagenia sp.	607		316	G
Pentagenia vittigera	194			G
Heptageniidae				
Stenonema integrum				G,S
Tricorythidae				
Tricorythodes sp.				G
Odonata				
Gomphidae				
Dromogomphus sp.				P
Turbellaria				
Tricladida				
Dugesia tigrina				S
Hemiptera		24		P
Plecoptera			24	P,SH,G
Copepoda			121	S,F
Cladocera				
Daphnidae				
Daphnia sp.			24	F
Arachnida			24	P
Gastropoda		49		S,SC
Pelecypoda	121			F
Corbiculidae				
Corbicula fluminea		24		F
Amphipoda				
Corophidae				
Corophium lacustre			97	SC
Gammaridae				
Gammarus sp.			49	SC
Isopoda				
Asellidae				
Lirceus sp.			24	SC
Annelida				
Oligochaeta				
Enchytraeidae			24	D
Tubificidae				D
Aulodrilus piqueti	49		24	D

(Continued)

Table 7 (Concluded)

Taxon	August	November	January	Functional Group
Branchiura sowerbyi	49		49	D
Limnodrilus cervix	24		24	D
L. hoffmeisteri	24		49	D
L. maumeensis	218	24	24	D
L. udekemeanus	24			D
Tubificidae, n.c. *	874	437	510	D
Tubificidae, c. *			121	D
Naididae				
Nais communis	73	24		D
N. pardalis			97	D
N. sp.				D
Total Density (no./sq m)	334	224	329	
SD of Density	334	152	522	
Number of Taxa	24	14	30	

* n.c. indicates tubificid immatures lacking capilliform chaetae; c. indicates tubificid immatures with capilliform chaetae.

(Sheet 3 of 3)

Table 8

Fish Sampling Effort by Gear Type, Month, Habitat, and Microhabitat*

Habitat Microhabitat	August			September			October			November			January			Total		
	EF	SN	GN	EF	SN	GN	EF	SN	GN	EF	SN	GN	EF	SN	GN	EF	SN	GN
Stack Island Pool																		
Pool sandbar	5	7	1	5	7	1	7	7	3	7	7	2	6	7	3	30	35	10
Natural bank	6	7	1	6	7	1	7	0	0	7	0	0	6	7	2	32	21	4
Dikes	4	0	2	4	0	2	0	0	0	0	0	0	1	0	0	9	0	4
Midpool	2	0	1	2	0	1	1	0	0	2	0	0	2	0	0	9	0	2
Total	17	14	5	17	14	5	15	7	3	16	7	2	15	14	5	80	56	20
Ajax Bar																		
Pool sandbar	3	5	1	3	5	1	2	0	0	2	0	0	3	5	1	13	15	3
Natural bank	3	4	1	3	5	1	6	6	2	8	0	0	5	6	3	25	21	7
Dikes	6	8	2	6	5	2	3	1	0	0	0	0	6	4	1	21	18	6
Midpool	2	0	1	2	0	1	2	0	0	1	0	0	2	0	0	9	0	2
Total	14	17	5	14	15	5	13	7	2	11	0	0	16	15	5	68	54	18
River Sandbar	5	11	0	6	12	0	7	7	0	7	7	0	7	12	0	32	49	0
Total	36	42	10	37	41	10	35	21	5	34	14	2	38	41	10	180	159	38

* EF = electrofisher; SN = seine; GN = gill net.

Table 9

Numerical Fish Catch Per Unit Effort in Three Lower Mississippi River Aquatic Habitats

Gear* / Month / Microhabitat**	Stack Island Pool	Ajax Bar Pool	River Sandbar
Electroshocker			
August			
Natural bank	21.2	21.3	
Pool sandbar	20.4	21.0	
Dike	9.5	37.8	
Midpool	0.0	1.0	
Total	15.7	25.4	9.5
September			
Natural bank	4.7	13.3	
Pool sandbar	40.8	32.0	
Dike	4.0	12.0	
Midpool	0.0	7.5	
Total	14.6	15.9	11.6
October			
Natural bank	7.4	10.3	
Pool sandbar	16.6	0.0	
Dike	†	10.0	
Midpool	0.0	2.0	
Total	11.2	7.4	4.0
November			
Natural bank	8.1	5.9	
Pool sandbar	1.9	0.0	
Dike	†	†	
Midpool	0.0	2.0	
Total	5.0	4.5	1.5
January			
Natural bank	0.8	7.8	
Pool sandbar	5.5	0.0	
Dike	0.0	0.0	
Midpool	0.0	0.0	
Total	2.5	2.4	2.8

(Continued)

* Units of effort are: electroshocker, 10-min transect; seine, single haul; gill net, single net-day.

** Microhabitats are found only within the two pools.

† Gear use precluded.

Table 9 (Concluded)

Gear Month Microhabitat	Stack Island Pool		Ajax Bar Pool		River Sandbar
Seine					
August					
Natural bank	58.7		56.5		
Pool sandbar	171.4		77.2		
Dike	*		43.6		
Total		115.1		56.5	30.8
September					
Natural bank	31.4		63.6		
Pool sandbar	34.1		37.4		
Dike	*		20.0		
Total		32.8		40.3	44.0
October					
Natural bank	*		39.7		
Pool sandbar	48.6		*		
Dike	*		78.0		
Total		48.6		45.1	62.6
November					
Natural bank	*		*		
Pool sandbar	11.8		*		
Dike	*		*		
Total		11.8		*	13.4
January					
Natural bank	2.0		16.7		
Pool sandbar	17.1		0.4		
Dike	*		0.0		
Total		9.6		6.8	1.5
Gill Net**					
August		17.4		37.2	*
September		6.0		42.0	*
October		17.7		19.0	*
November		17.5		*	*
January		2.8		4.4	*

* Gear use precluded.
** Gill net catches not separated by microhabitat due to low sample sizes.

Table 10

Numerical Catch Per 10 Minutes of Electroshocking of the Dominant Fish Species

Collected in Stack Island Pool*

Month	Pool Sandbar		Natural Bank		Dike		Midpool
August	Gizzard shad	13.4	Gizzard shad	12.1	Gizzard shad	5.3	(No catch)
	Threadfin shad	0.6	Threadfin shad	0.5	Flathead catfish	1.5	
					White bass	0.8	
					Blue sucker	0.8	
September	Gizzard shad	26.1	Gizzard shad	0.6	Flathead catfish	2.0	(No catch)
	Threadfin shad	1.6			Blue catfish	0.6	
	Silvery minnow	1.5					
	Channel catfish	0.5					
October	River carpsucker	4.6	Smallmouth buffalo	1.5	(No sample)		(No catch)
	Freshwater drum	3.1	Freshwater drum	0.7			
	Silver chub	1.3	Silvery minnow	0.6			
	Gizzard shad	0.9	Goldeye	0.5			
	Smallmouth buffalo	0.8					
	Flathead catfish	0.8					
	Blue catfish	0.6					
	Channel catfish	0.5					
	Common carp	0.5					
November	Smallmouth buffalo	0.6	Smallmouth buffalo	2.5	(No sample)		(No catch)
			Freshwater drum	1.5			
			Gizzard shad	0.9			
			Blue catfish	0.9			
January	Shortnose gar	2.2	(No species > 0.5)		(No catch)		(No catch)
	River carpsucker	1.5					

* Dominant species are defined as those having catches > 0.5 per unit effort.

Table 11

Numerical Catch Per Seine Haul of the Dominant Fish Species Collected in Stack Island Pool*

Month	Pool Sandbar		Natural Bank	
August	Threadfin shad	88.9	Emerald shiner	39.1
	River shiner	29.6	River shiner	5.7
	Emerald shiner	26.7	Inland silverside	4.6
	Silverband shiner	7.0	Silverband shiner	2.6
	Gizzard shad	6.4	Blacktail shiner	2.6
	River carpsucker	4.7		
	Inland silverside	2.4		
	Blacktail shiner	2.3		
September	Emerald shiner	15.6	Emerald shiner	21.0
	River shiner	7.7	Silverband shiner	3.0
	Threadfin shad	2.4	Blacktail shiner	2.7
	River carpsucker	2.4	River shiner	1.9
	Blacktail shiner	1.7		
	Gizzard shad	1.4		
	Inland silverside	1.1		
	Silverband shiner	1.0		
October	Emerald shiner	26.4	(No sample)	
	Silverband shiner	4.9		
	River shiner	4.3		
	Speckled chub	3.3		
	Blacktail shiner	2.3		
	Inland silverside	2.3		
	Mimic shiner	2.3		
	Bullhead minnow	1.3		
	Channel catfish	1.0		
November	River shiner	6.3	(No sample)	
	Emerald shiner	1.4		
	Blacktail shiner	0.9		
	Silverband shiner	0.6		
January	River shiner	15.4	River shiner	0.7
			Blacktail shiner	0.4

* Dominant species are defined as those having catches > 1.0 per unit effort.

Table 12

Numerical Catch Per Gill Net-Day of the Dominant Fish Species Collected in Stack Island Pool and Ajax Bar Pool*

Month	Stack Island Pool		Ajax Bar Pool	
August	Gizzard shad	9.8	Gizzard shad	25.2
	Blue catfish	2.1	River carpsucker	2.4
	Shortnose gar	0.8	Blue catfish	2.2
	River carpsucker	0.8	Freshwater drum	2.0
	Flathead catfish	0.8	Shortnose gar	1.6
			Skipjack herring	1.4
			White bass	1.0
September	Freshwater drum	2.4	Gizzard shad	22.4
	Shortnose gar	1.2	Blue catfish	6.4
	Blue catfish	0.8	River carpsucker	3.2
			Freshwater drum	2.8
			Skipjack herring	2.6
			White bass	1.6
			Shortnose gar	1.0
			Sauger	0.8
October	Gizzard shad	5.7	Blue catfish	9.0
	Longnose gar	2.0	Gizzard shad	7.5
	Shortnose gar	1.7	Freshwater drum	3.5
	Goldeye	1.7	Shortnose gar	1.5
	Blue catfish	1.7	White bass	1.5
	Freshwater drum	1.7	Shovelnose sturgeon	1.5
	Smallmouth buffalo	1.0	Longnose gar	1.0
November	Shortnose gar	3.5	(No sample)	
	River carpsucker	3.0		
	Freshwater drum	2.5		
	Smallmouth buffalo	1.5		
	Sauger	1.5		
	Gizzard shad	1.0		
	Goldeye	1.0		
	Blue catfish	1.0		
January	Smallmouth buffalo	0.8	Goldeye	1.6
	Shortnose gar	0.5	Sauger	0.8
	Goldeye	0.5	River carpsucker	0.8
	Sauger	0.5	Blue catfish	0.5

* Dominant species are defined as those having catch rates > 0.5 per unit effort.

Table 13

Numerical Catch Per 10 Minutes of Electroshocking of the Dominant Fish Species Collected in Ajax Bar Pool*

Month	Pool Sandbar		Natural Bank		Dike		Midpool	
August	Gizzard shad	0.9	Gizzard shad	12.0	Gizzard shad	11.3	(No catch)	
			Threadfin shad	4.9	Threadfin shad	1.9		
					Flathead catfish	1.1		
September	Gizzard shad	13.0	Gizzard shad	4.0	Gizzard shad	2.3	Gizzard shad	4.5
	Threadfin shad	2.3	Threadfin shad	1.3	White bass	1.6		
			White bass	1.2				
			Blue catfish	0.8				
			Bluegill	0.6				
			Common carp	0.5				
October	(No catch)		Gizzard shad	1.2	Gizzard shad	1.8	Gizzard shad	0.8
			River carpsucker	1.2				
			Threadfin shad	0.8				
			White bass	0.7				
			Freshwater drum	0.6				
			Smallmouth buffalo	0.6				
			Common carp	0.5				
November	(No catch)		Blue catfish	1.9	(No sample)		Skipjack herring	1.5
			Gizzard shad	1.2				
			Goldeye	0.5				
January	(No catch)		River carpsucker	0.7	(No catch)		(No catch)	
			Longear sunfish	0.5				

* Dominant species are defined as those having catches > 0.5 per unit effort.

Table 14

Numerical Catch Per Seine Haul of the Dominant Fish Species

Collected from Ajax Bar Pool*

Month	Pool Sandbar		Natural Bank		Dike	
August	Threadfin shad	30.8	Gizzard shad	15.2	Threadfin shad	24.5
	River carpsucker	19.8	Emerald shiner	11.0	Emerald shiner	10.2
	River shiner	7.0	Threadfin shad	7.8	River shiner	10.0
	Emerald shiner	5.5	Blacktail shiner	6.0	Silverband shiner	1.8
	Inland silverside	1.2	River shiner	5.6	Gizzard shad	1.2
			Bullhead minnow	2.6		
			Silverband shiner	1.0		
September	River shiner	12.4	Emerald shiner	37.0	Emerald shiner	9.5
	Emerald shiner	10.4	Threadfin shad	7.5	River shiner	3.3
	River carpsucker	9.2	Silverband shiner	5.2	Threadfin shad	2.0
	Gizzard shad	2.8	River shiner	3.8		
	Blacktail shiner	1.0	Blacktail shiner	3.3		
October	(No sample)		Silverband shiner	24.7	(No sample)	
			Inland silverside	5.1		
			River shiner	4.7		
			Emerald shiner	4.3		
			Threadfin shad	1.7		
			Blacktail shiner	1.6		
November	(No sample)		(No sample)		(No sample)	
January	(No species > 1.0)		River shiner	10.4	(No catch)	
			Blacktail shiner	1.6		
			Emerald shiner	1.0		
			Speckled chub	1.0		

* Dominant fish species defined as those with numerical catch rates > 1.0 per unit of effort.

Table 15

Numerical Catch Per 10 Minutes of Electroshocking of the Dominant Fish Species Collected in the River Sandbar Habitat*

Month	Species	Catch
August	Gizzard shad	5.5
	Threadfin shad	3.3
	Blue catfish	0.9
September	Gizzard shad	8.8
	Blue catfish	0.8
October	Gizzard shad	2.4
	Threadfin shad	0.5
November	Gizzard shad	0.6
January	River carpsucker	1.4
	Smallmouth buffalo	0.7
	Shortnose gar	0.5

* Dominant species are defined as those having catches > 0.5 per unit effort.

Table 16

Numerical Catch Per Seine Haul of the Dominant Fish Species Collected in the River Sandbar Habitat*

Month	Species	Catch
August	Threadfin shad	15.1
	Emerald shiner	4.7
	River shiner	4.6
	River carpsucker	4.1
	Inland silverside	2.9
	Blacktail shiner	1.3
September	River shiner	15.0
	Emerald shiner	10.3
	Blacktail shiner	7.1
	River carpsucker	5.2
	Threadfin shad	3.3
	Silverband shiner	1.9
	Inland silverside	1.6
	Gizzard shad	1.1
October	Speckled chub	17.4
	River shiner	13.0
	Channel catfish	6.9
	Silverband shiner	6.4
	Threadfin shad	4.3
	Emerald shiner	3.7
	River carpsucker	3.4
	Blacktail shiner	2.9
	Bullhead minnow	1.6
	Mimic shiner	1.4
	Inland silverside	1.0
November	River shiner	7.0
	Emerald shiner	2.0
	Speckled chub	1.1
	Silver chub	1.1
January	(no species > 1.0)	

* Dominant species are defined as those having catches > 1.0 per unit effort.

Table 17

Fish Collected by Rotenone During the Dike Systems Study, September 1986

Species	Estimated Number	Estimated Weight, lb
Gizzard shad	12,900*	2,026.20
Threadfin shad	357,500*	4,719.00
Freshwater drum	2,030*	7.51
River carpsucker	1,810*	3.28
White crappie	20*	0.55
Smallmouth buffalo	5	12.36
Bluegill	8	0.57
Skipjack herring	2	0.83
Channel catfish	18	8.32
Blue catfish	15	9.46
Flathead catfish	8	4.11
Goldeye	1	0.04
Paddlefish	2	0.85
Misc.**	2,000	2.20
Total	376,300	6,795.28
		(3,397.64 lb/ac)

* Predominantly young-of-year.

** Includes, in estimated rank order of abundance: Inland silversides, emerald shiner, river shiner, Mississippi silvery minnow, and blackstripe topminnow.

Table 18

Mean Density of Fish Larger Than 2 cm Occurring in Different Microhabitats Associated with Stack Island and Ajax Bar Pools as Determined by Hydroacoustic Surveys

Dike Pool and Microhabitat*	Sample** Number	Mean Number of Fish per hectare (SE) August	November	January
Stack Island Pool				
Main pool	10	231 (31)	6 (6)	3 (3)
Plunge pool	6	219 (12)	30 (12)	27 (6)
Downstream dike	6	7 (7)	4 (4)	0 (0)
Natural bank	2†	763	125	208
Midpool	2	205	0	12
Pool sandbar	2	96	5	0
Ajax Bar				
Main pool	10	247 (57)	4 (3)	21 (9)
Upstream dike	6	163 (56)	244 (96)	147 (54)
Scour hole	6	115 (25)	191 (100)	109 (41)
Natural bank	2	212	416	140

* Location and transect scheme for pool microhabitats are shown in Figure 14.

** n = number of transects for morning and afternoon surveys combined at each sampling period.

† Degrees of freedom for error, combining two surveys, is 2 [(n/2)-1]; therefore, standard errors cannot be calculated for n < 3.

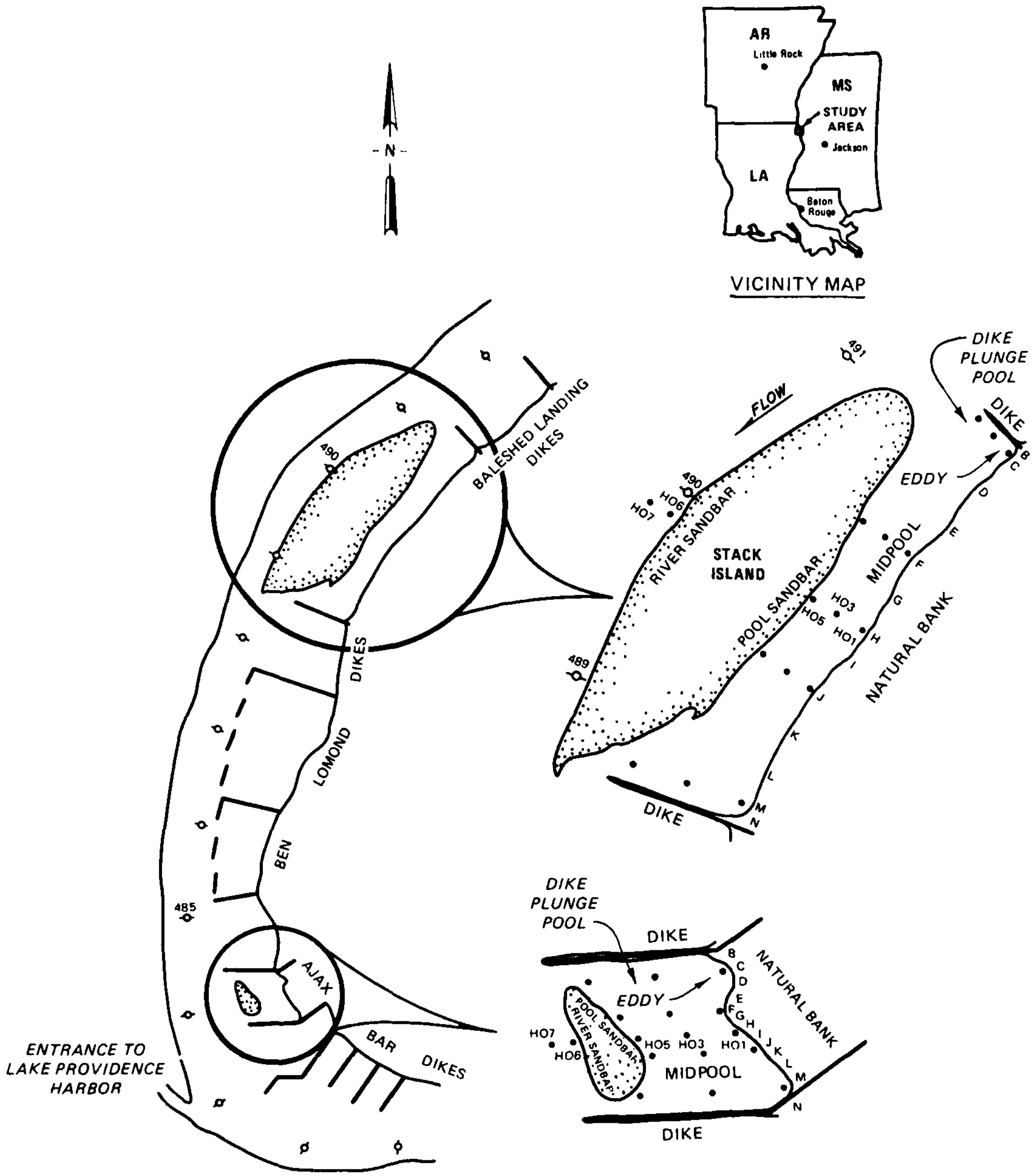

Figure 1. Location and approximate configuration of Stack Island Pool and Ajax Bar Pool. Microhabitat types present within the pools are also indicated

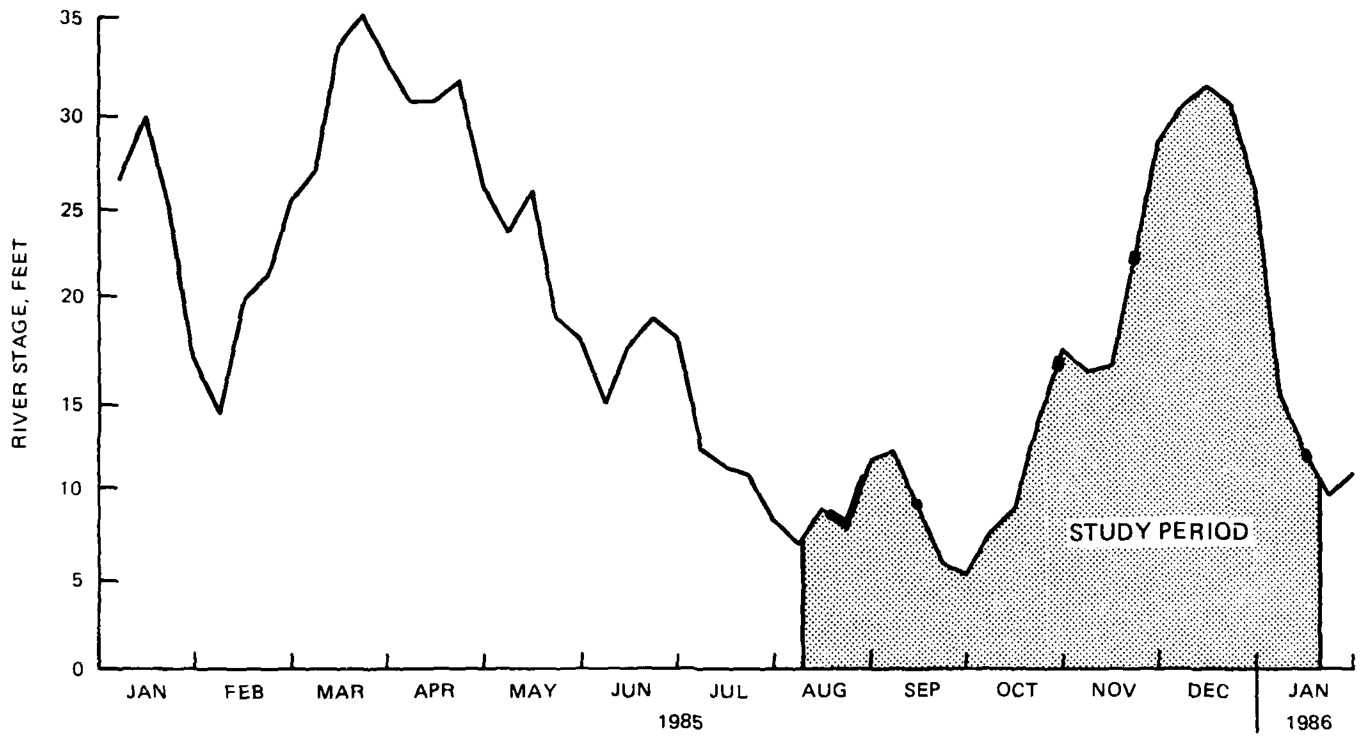

Figure 2. Diagrammatic representation of hydroacoustic survey transects within the two study pools. Microhabitats sampled are indicated by parallel lines, with the number of transects given in parentheses. Identical surveys were conducted in all three months. Two replicate surveys were made in each pool in each month

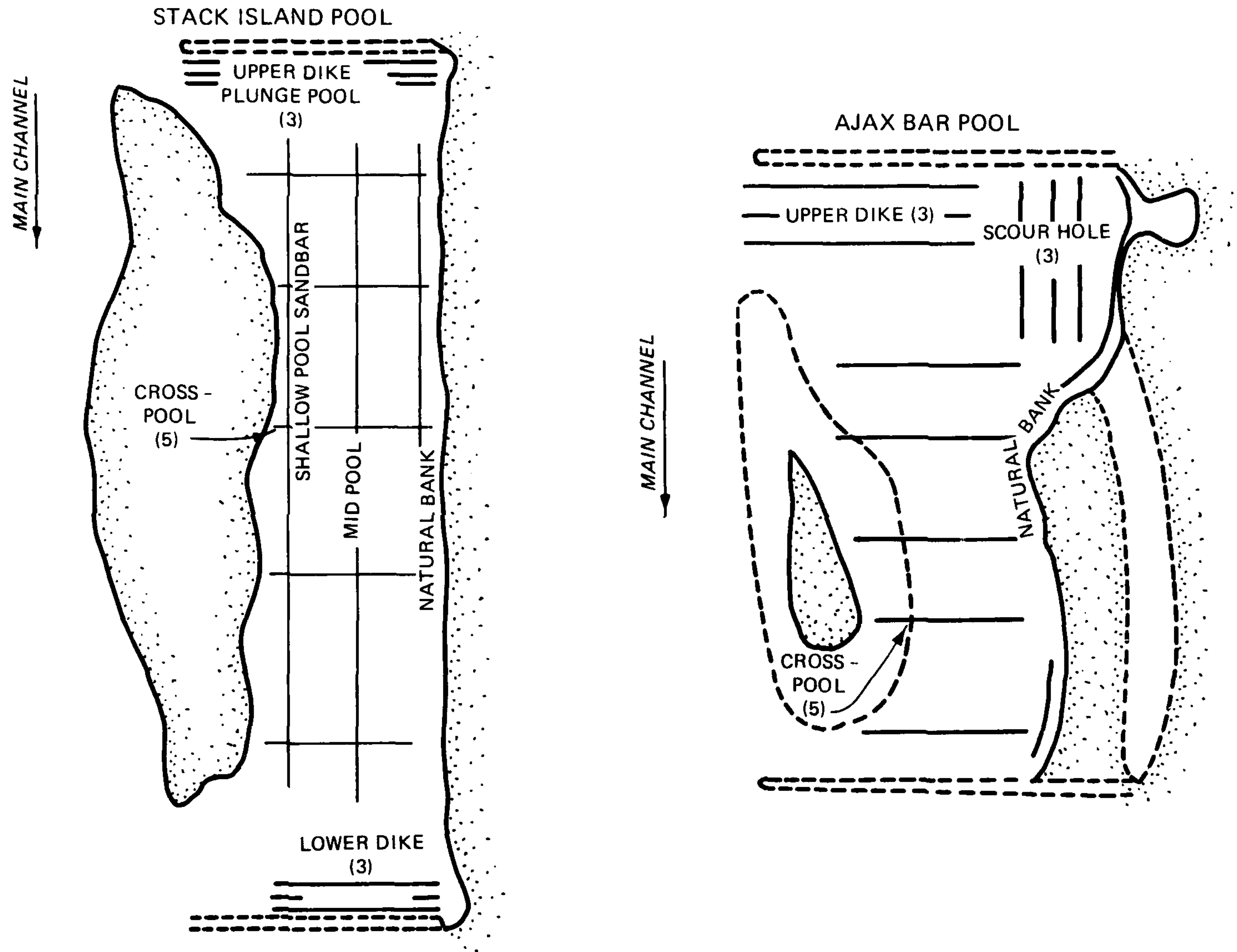

Figure 3. River hydrograph for the Vicksburg gage for January 1985 through 1986. The study period is indicated by stippling; actual sampling dates are indicated by solid rectangles along the upper edge of the stippling

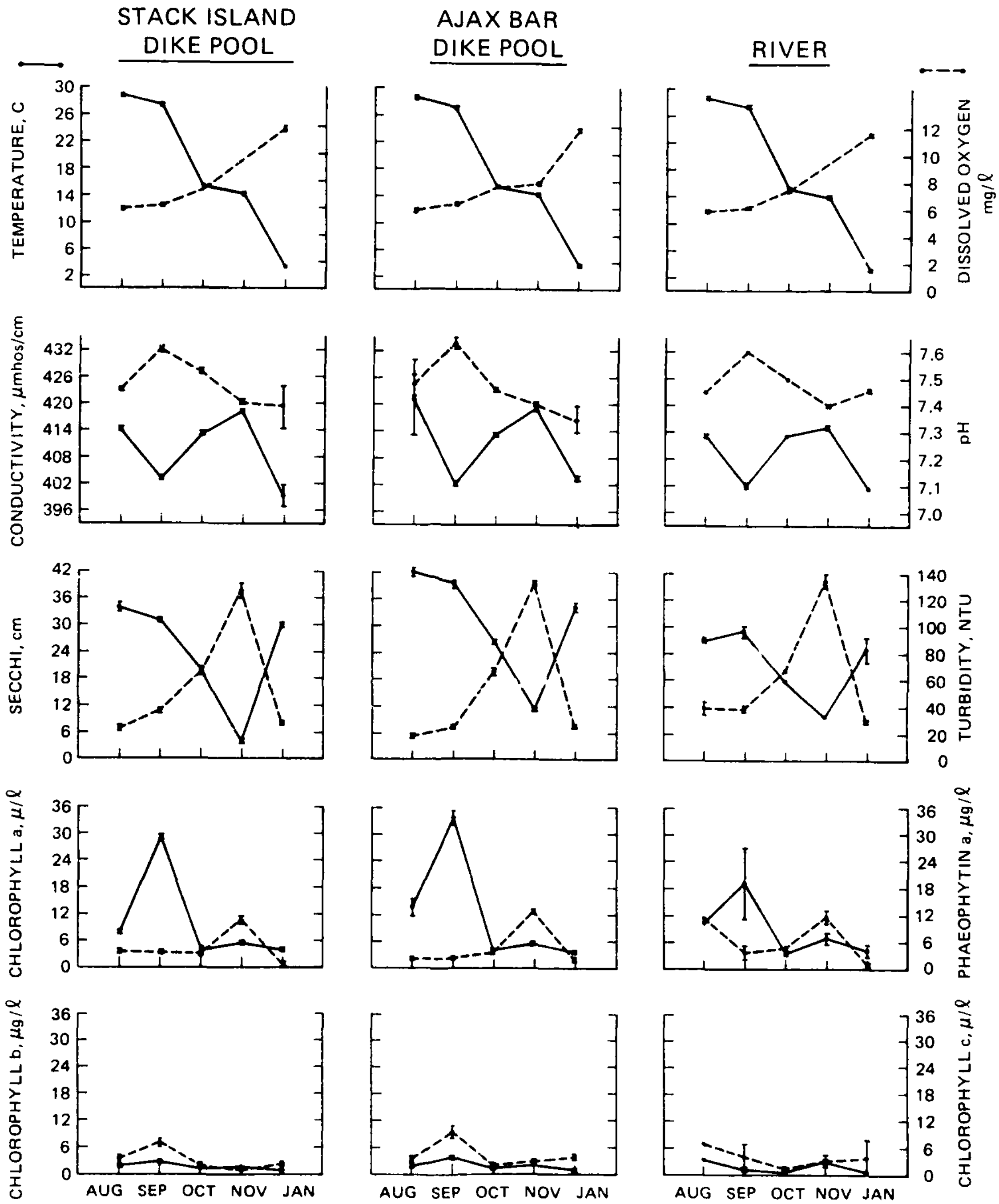

Figure 4. Monthly means for water quality variables and chlorophyll concentrations. Dots indicate mean values, and vertical lines one standard deviation about the mean

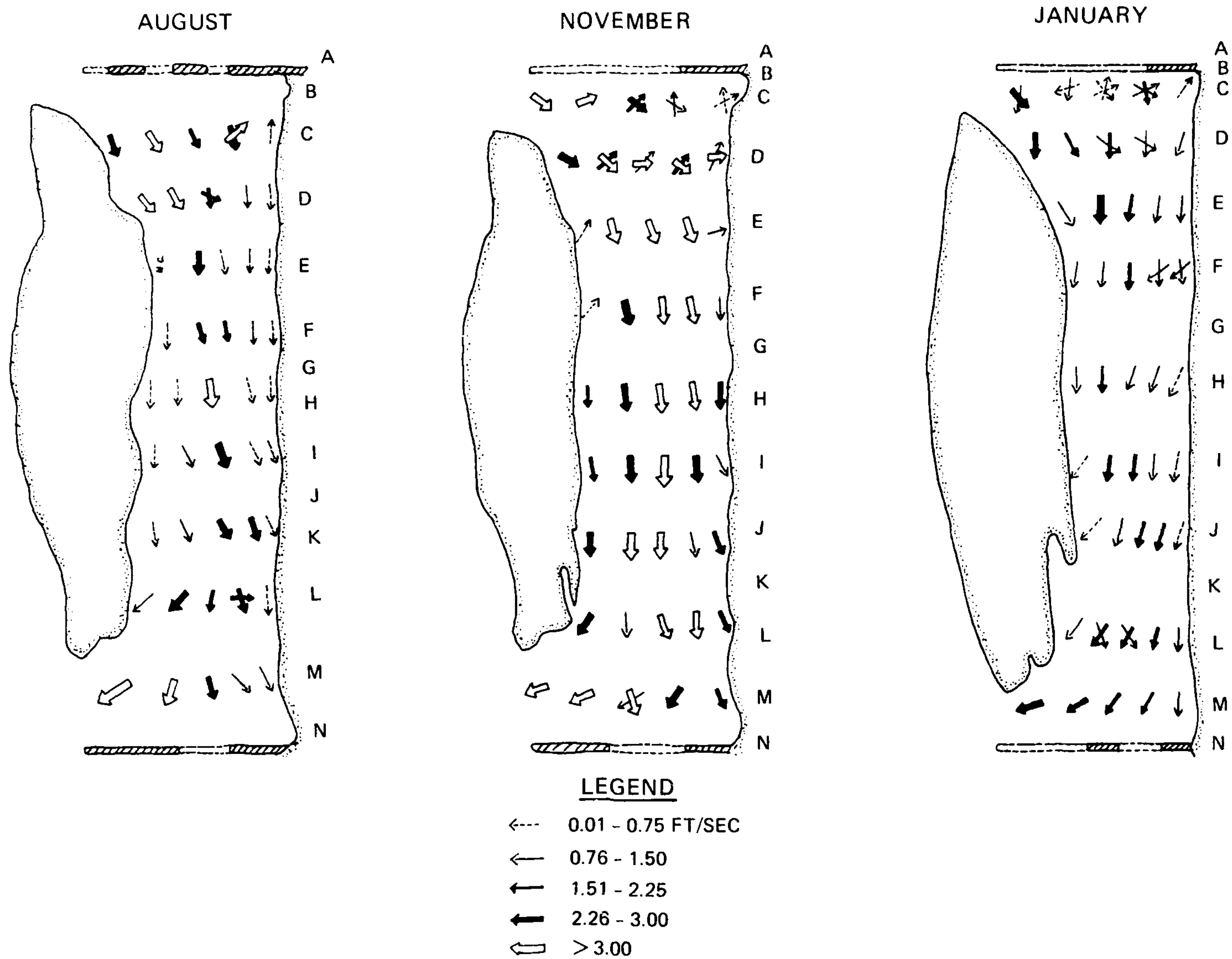

Figure 5. Magnitude and direction of currents measured within Stack Island Pool during August, November, and January. A single arrow indicates that currents were approximately in the same direction throughout the water column; multiple arrows indicate that current directions were variable with depth

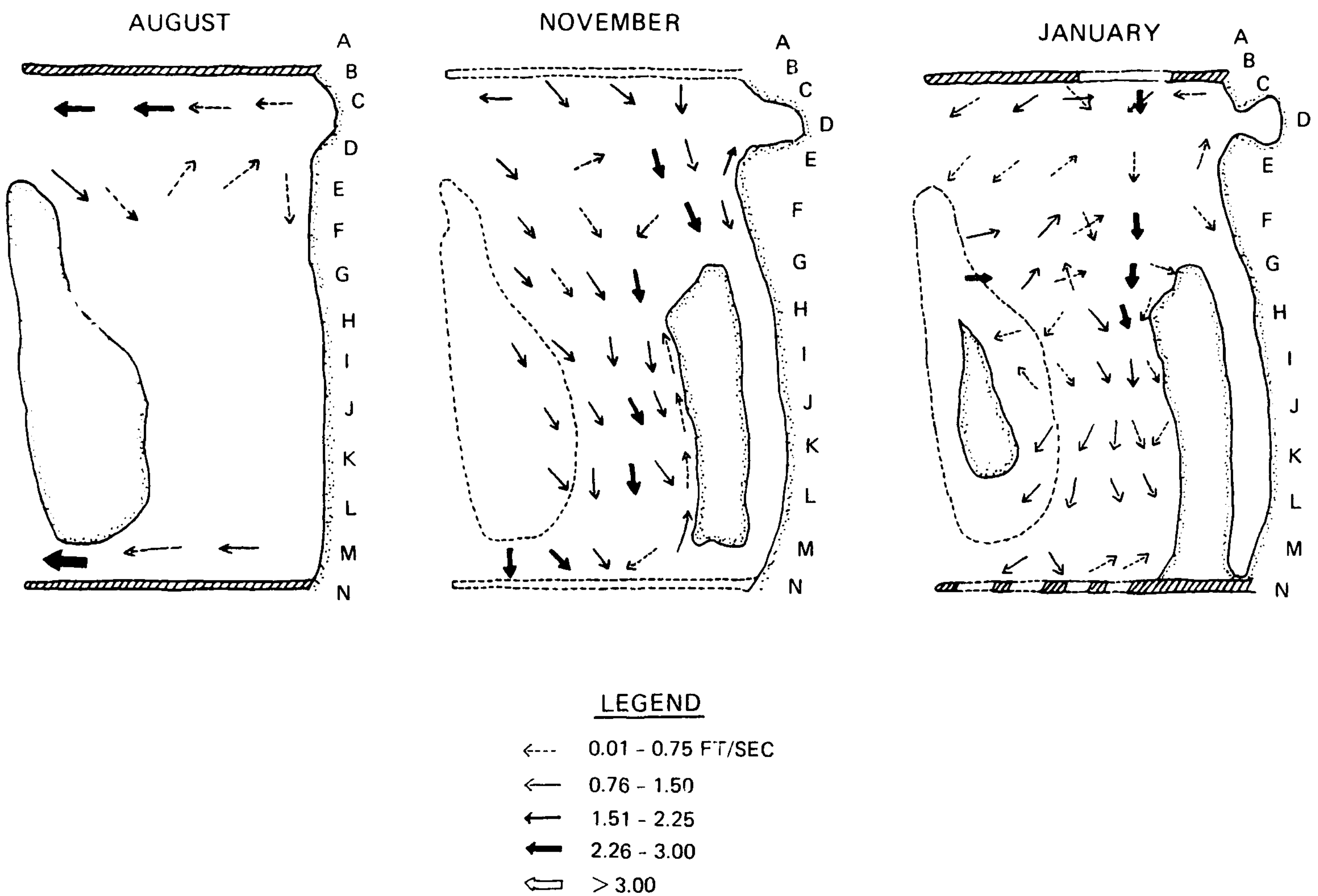

Figure 6. Magnitude and direction of currents measured within Ajax Bar Pool during August, November, and January. A single arrow indicates that currents were approximately in the same direction throughout the water column; multiple arrows indicate that current directions were variable with depth

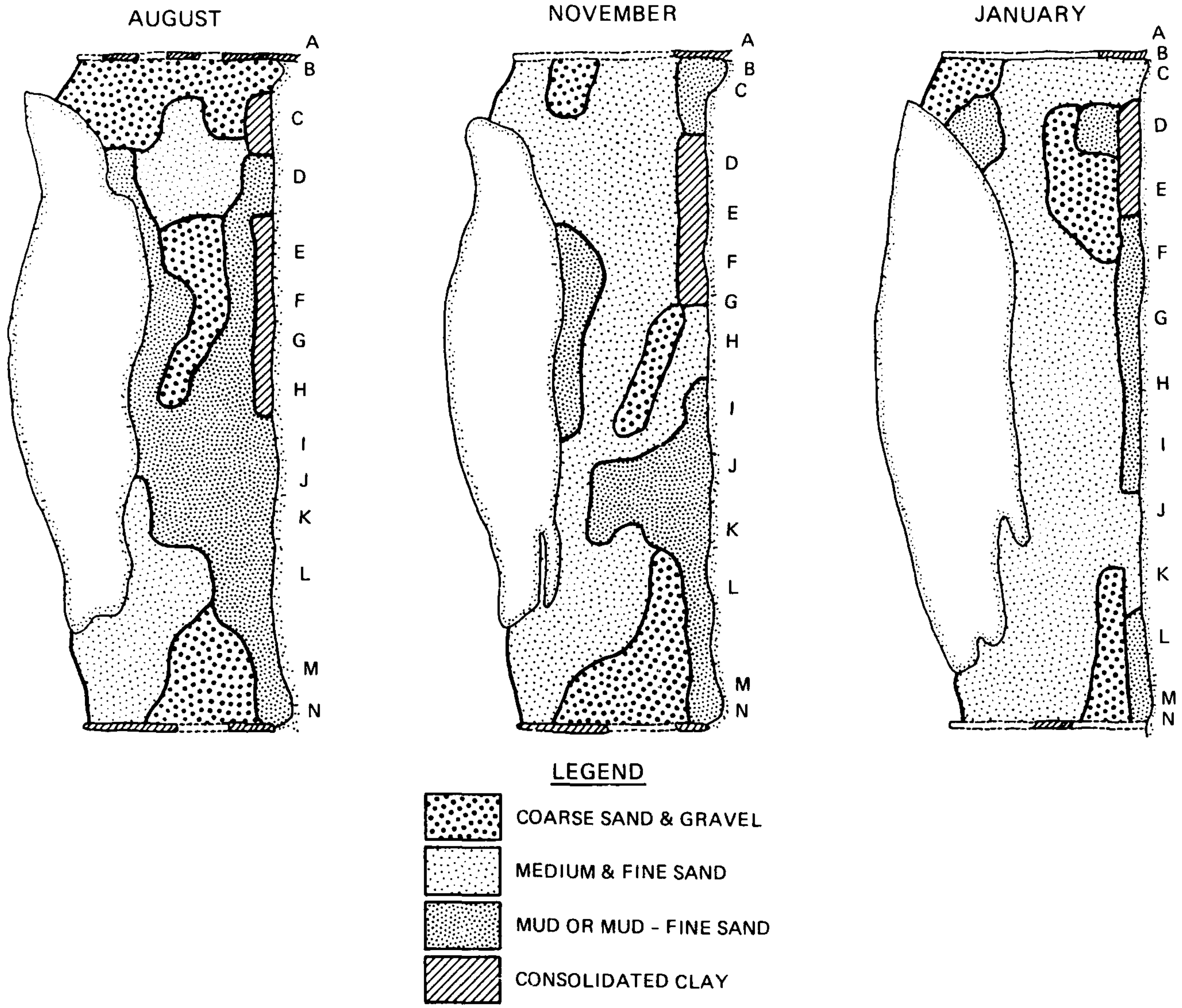

Figure 7. Distribution of substrate types within Stack Island Pool during August, November, and January

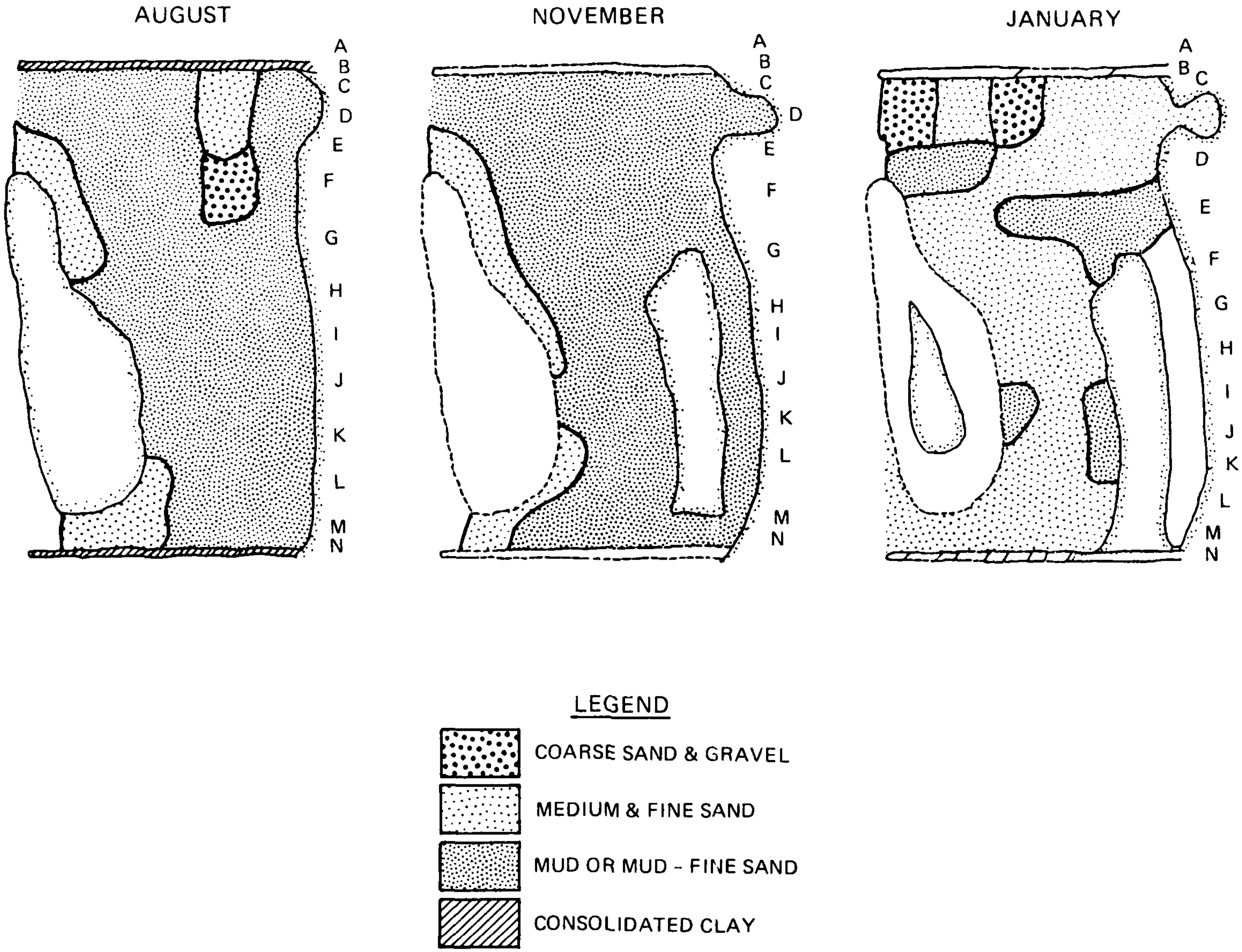

Figure 8. Distribution of substrate types within Ajax Bar Pool during August, November, and January

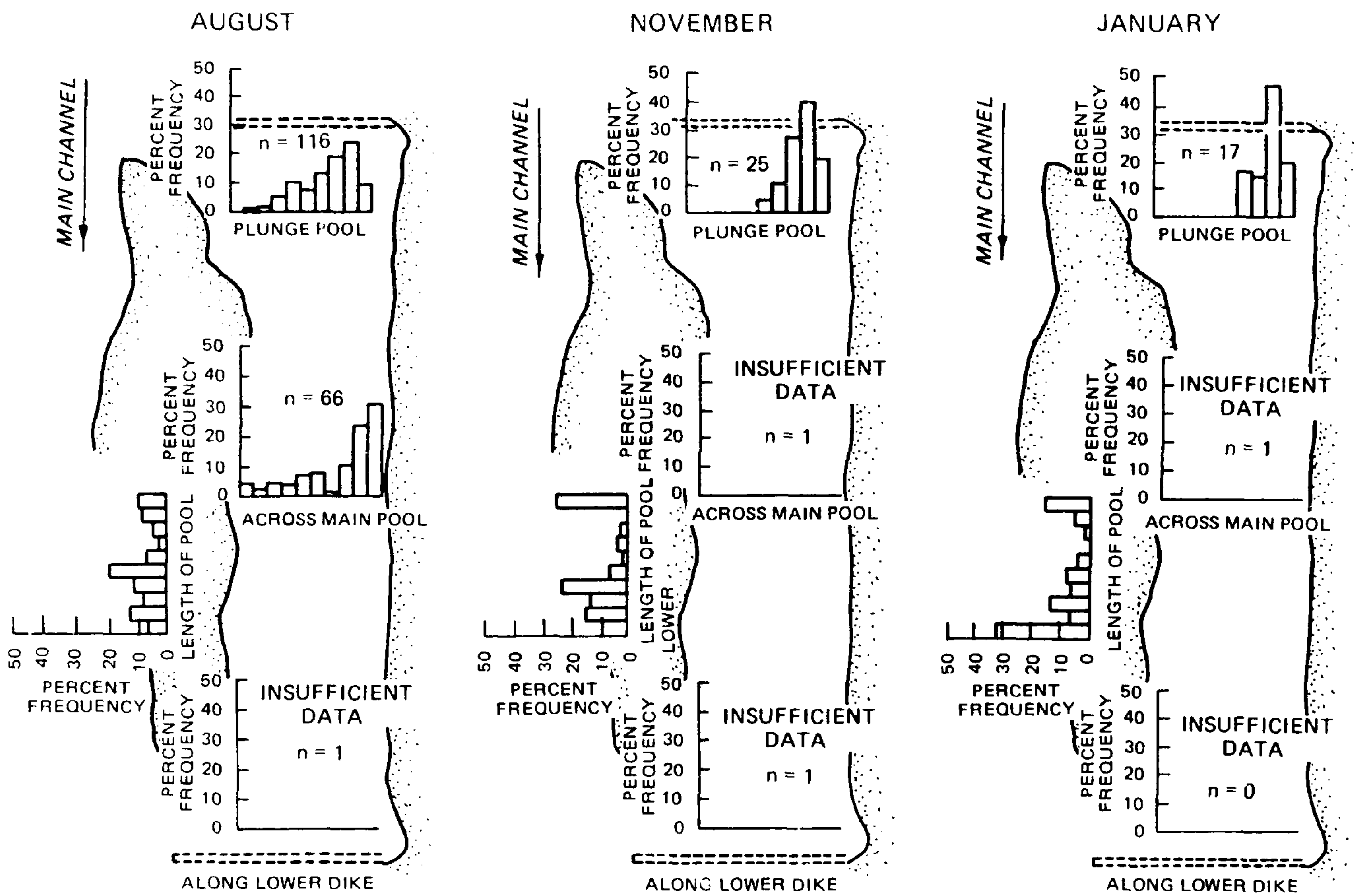

Figure 9. Spatial distribution of fishes detected dfuring hydroacoustic sampling of Stack Island Pool. Histograms show relative positions of fish along transects run in the direction of the x-axis through the habitats. Histograms show average distributions for several transects for two surveys each month

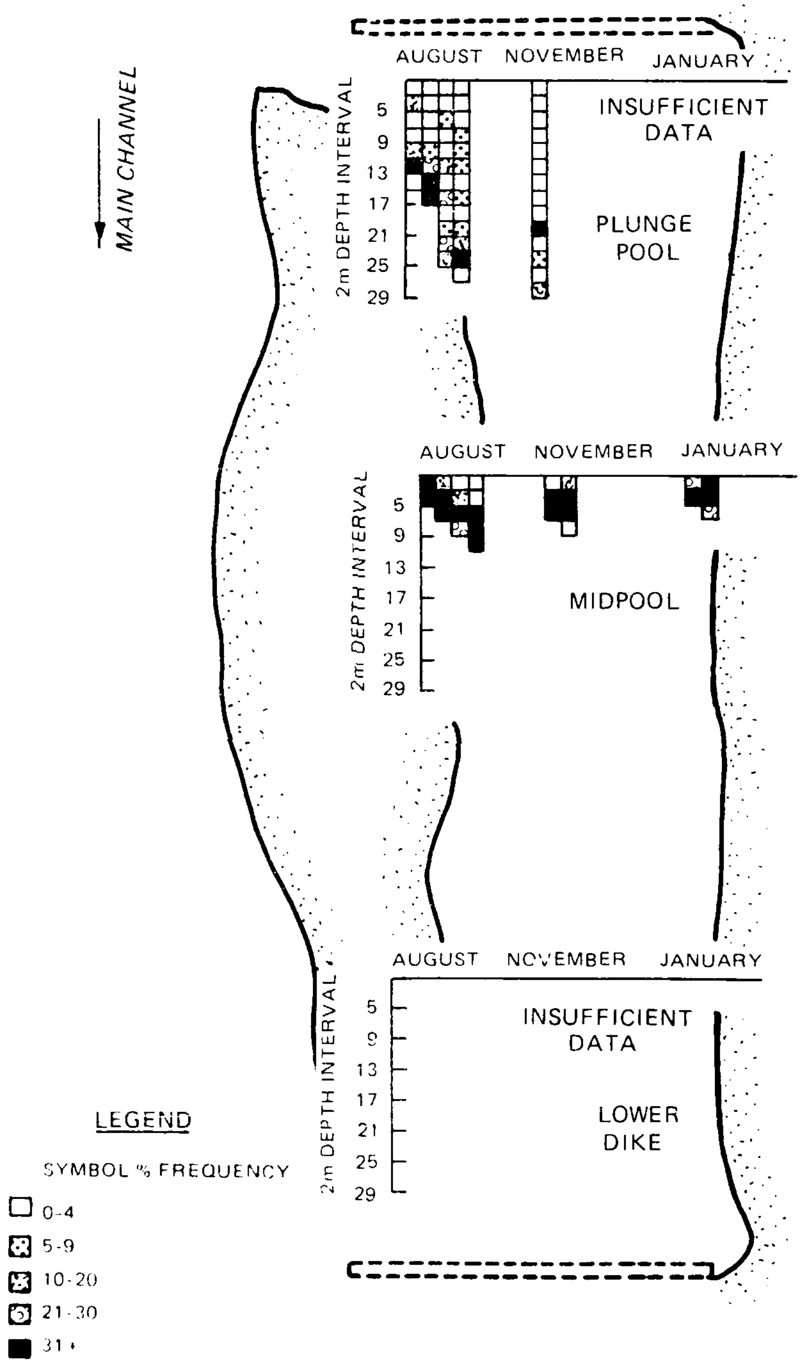

Figure 10. Depth distributions of fishes detected during hydroacoustic sampling of Stack Island Pool. Symbols indicated estimated numbers of fish detected within 2-m depth intervals

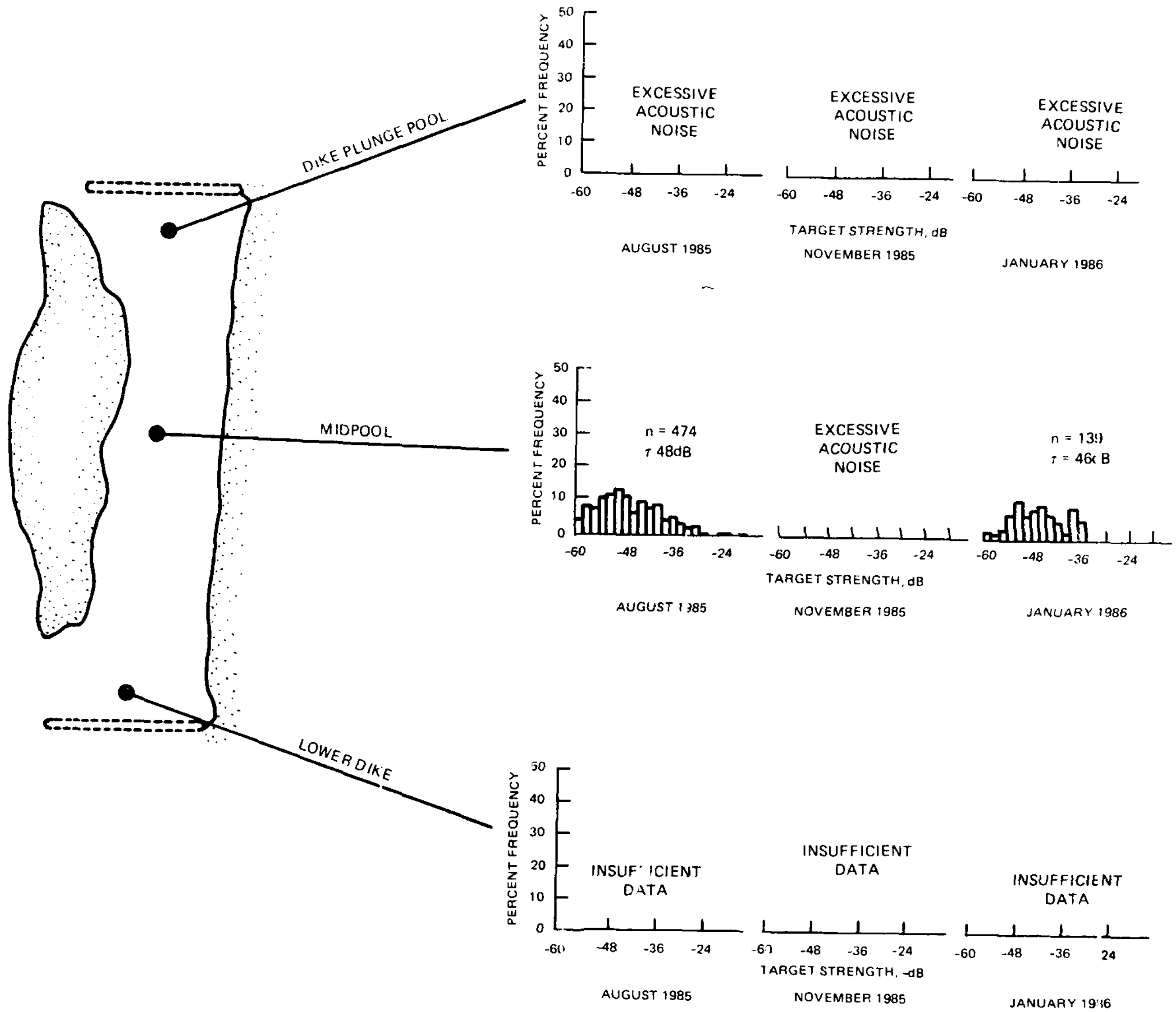

Figure 11. Size distribution of fish detected in hydroacoustic sampling of Smack Island Pool. N = number of echo returns from single-fish targets. Multiple echo returns from the same fish are possible. T = median size of targets

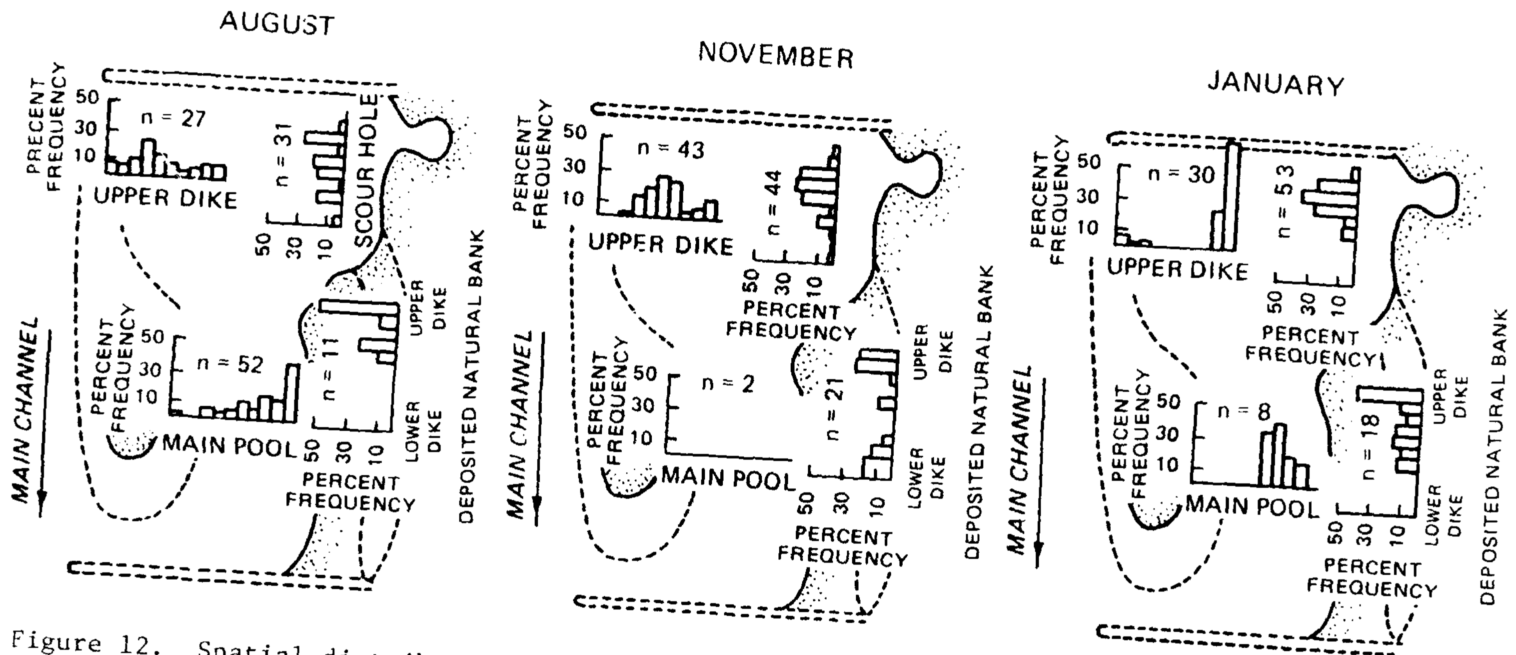

Figure 12. Spatial distribution of fishes detected during hydroacoustic sampling of \jax Bar Pool. Histograms show relative positions of fish along transects run in the directio1 of the x-axis through the habitats. Histograms show average distributions for several transects for two surveys each month

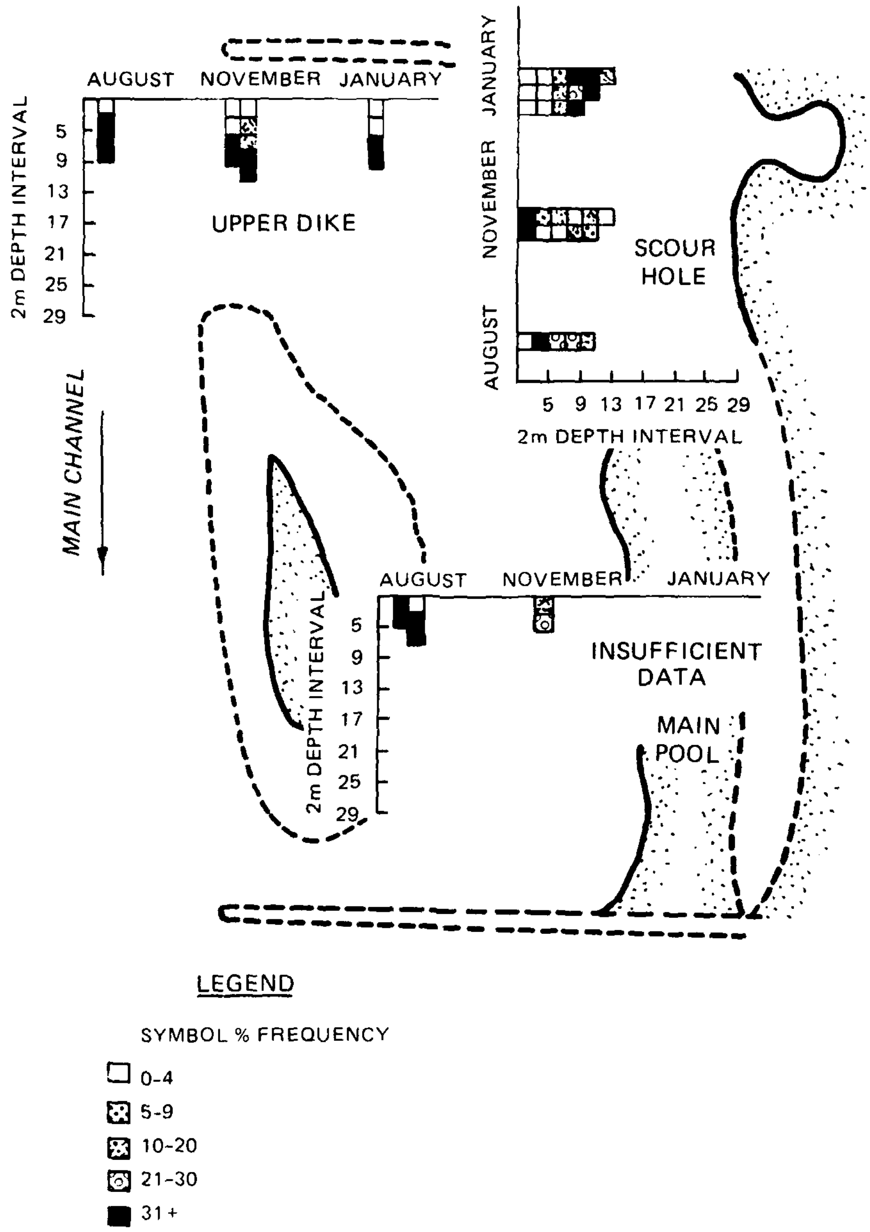

Figure 13. Depth distributions of fishes detected during hydroacoustic sampling of Ajax Bar Pool. Symbols indicated estimated numbers of fish detected within 2-m depth intervals

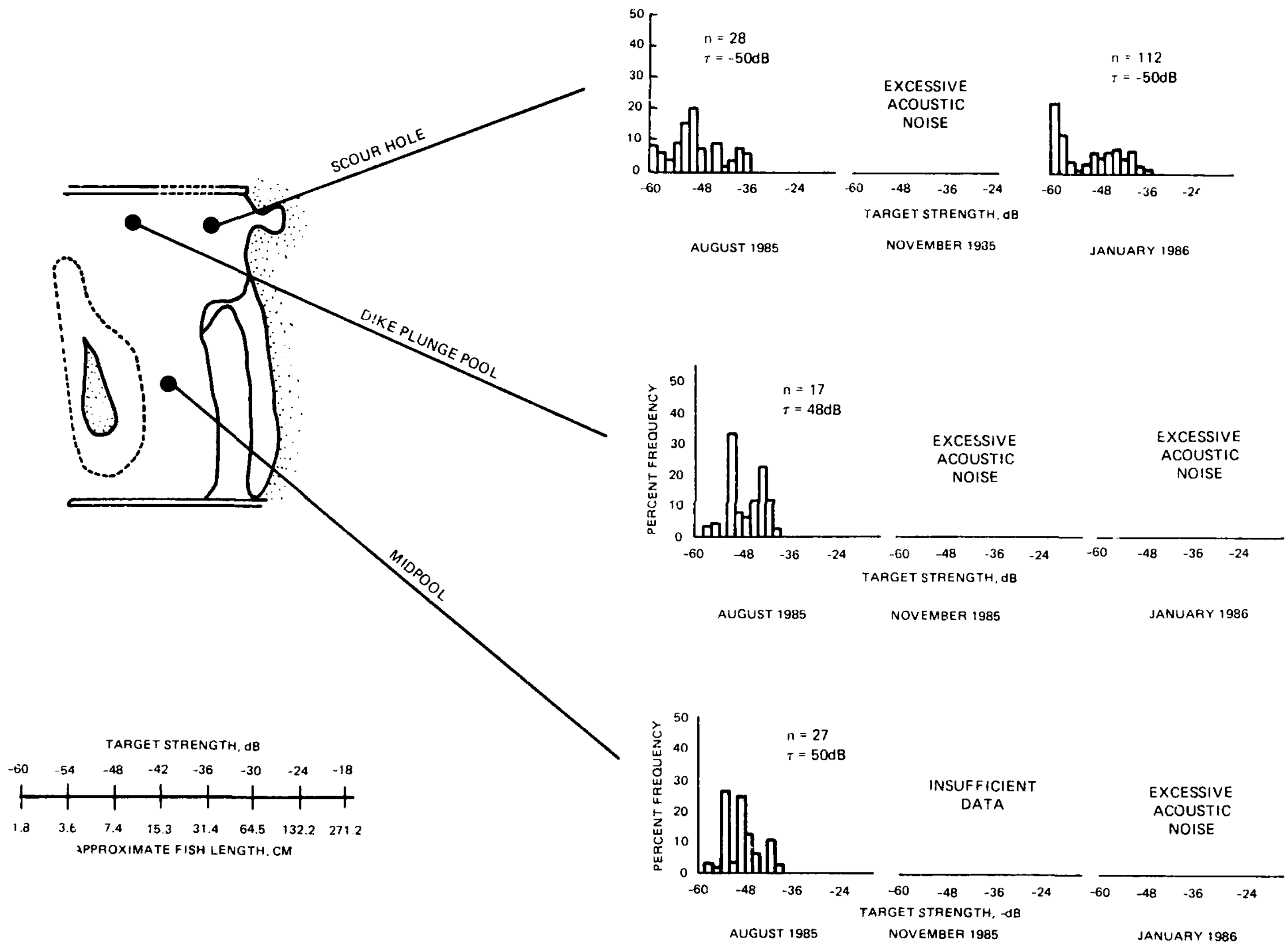

Figure 14. Size distribution of fish detected in hydroacoustic sampling of Ajax Bar Pool. N = number of echo returns from single-fish targets. Multiple echo returns from the same fish are possible. T = median size of targets

APPENDIX A

FISH CATCH BY HABITAT, MICROHABITAT, AND GEAR TYPE

Table A1

Total Number (N) and Weight in Grams (W) of Fishes Collected at the Pool Sandbar of Stack Island Pool by Sample Period and Gear Type*

Species		August			September			October			November			January		
		EF	SN	GN	EF	SN	GN	EF	SN	GN	EF	SN	GN	EF	SN	GN
Shovelnose sturgeon	N												1			
	W												590.0			
Paddlefish	N												1			
	W												1,720.0			
Longnose gar	N	1								6			1			1
	W	2,450.0								19,170.0			405.0			2,063.0
Shortnose gar	N	2		3	2		4	1		5	1		7	15		2
	W	291.0		4,301.0	960.0		5,190.0	756.0		7,785.0	1,459.0		6,694.0	8,255.0		1,722.0
Clupeidae	N		1													
	W		0.1													
Skipjack herring	N	1		3				1				1				
	W	10.0		293.0				6.0				4.8				
Gizzard shad	N	89	45	29	168	10	1	7	1	17	3		2	1		
	W	7,096.0	110.3	5,962.0	33,183.5	235.0	770.0	1,875.0	5.1	5,606.0	524.0		800.0	144.0		
Threadfin shad	N	4	622		8	17			5							
	W	48.0	381.9		75.0	24.0			2.2							
Goldeye	N							2		5	1		2			1
	W							57.0		950.0	38.9		430.0			166.0
Carp	N	1			2			4					1			1
	W	1,910.0			4,310.0			12,054.0					4,240.0			2,780.0
Mississippi silvery minnow	N		2		11			2	1							
	W		8.0		44.5			11.4	6.0							
Speckled chub	N		5					1	23			1				
	W		0.5					0.1	6.0			0.2				
Silvery chub	N							11				4				
	W							34.0				12.6				
Emerald shiner	N		187		2	109		1	185			11			2	
	W		68.4		8.7	31.5		2.8	200.0			15.8			2.3	
River shiner	N	1	207			54		2	30			50		1	108	
	W	1.6	32.1			12.0		3.4	19.4			38.3		4.1	42.6	
Pugnose minnow	N		1													
	W		0.3													
Red shiner	N					1						1			1	
	W					0.3						0.1			0.1	
Silverband shiner	N		49			7			34			5			2	
	W		7.0			0.8			15.1			2.6			1.4	
Blacktail shiner	N		16			12			16			7			1	
	W		1.7			1.3			3.0			1.5			0.1	
Mimic shiner	N		3			1			9			3			4	
	W		0.3			0.1			2.2			0.9			1.2	
Bullhead minnow	N		6			1			9						2	
	W		2.0			0.1			3.7						1.0	

(Continued)

* EF = electrofishing, SN = seine, and GN = gill net.

Table A1 (Concluded)

Species		August EF	August SN	August GN	September EF	September SN	September GN	October EF	October SN	October GN	November EF	November SN	November GN	January EF	January SN	January GN
River carpsucker	N	1	33	1		17		37	7	4		1	6	10		1
	W	14.5	18.4	1,270.0		24.0		1,166.0	9.5	1,783.1		3.4	3,917.0	9,167.0		668.0
Smallmouth buffalo	N			1				6		3	5		3	2		4
	W			1,903.0				6,208.0		4,815.0	9,859.0		9,150.0	1,424.0		3,807.0
Bigmouth buffalo	N									1				1		
	W									4,740.0				2,829.0		
Blue catfish	N			2	3			5		5	1		2			
	W			810.0	668.5			703.4		4,510.0	25.3		440.0			
Channel catfish	N		1	2	3		1	4	7	1		2				
	W		0.8	673.0	3,930.0		708.0	688.9	9.5	570.0		5.2				
Flathead catfish	N							6			1					
	W							7,199.0			808.0					
Mosquitofish	N											4				
	W											0.8				
Brook silverside	N					1										
	W					0.6										
Inland silverside	N	1	17			8			16			4				
	W	0.9	9.8			4.2			19.6			4.6				
White bass	N				3	1		1		1						
	W				949.4	29.4		233.0		560.0						
Striped bass	N															1
	W															1,990.0
Orangespotted sunfish	N													1		
	W													4.8		
Lepomis spp.	N		2													
	W		0.2													
White crappie	N												1			
	W												140.0			
Black crappie	N										1					
	W										272.0					
Logperch	N				1											
	W				2.3											
Sauger	N			1				1					3			1
	W			155.0				440.0					1,305.0			603.0
Freshwater drum	N		3	1				24	2	5			5	2		
	W		3.4	61.0				1,336.2	7.8	997.0			1,270.0	330.1		
Striped mullet	N	1			1											
	W	1,187.0			680.0											
Total	N	102	1,200	43	204	239	6	116	340	53	13	94	35	33	120	12
	W	13,309.0	645.2	15,428.0	44,811.9	363.6	6,668.0	32,774.2	304.9	51,486.1	12,986.2	90.8	30,381.0	22,158.0	48.7	13,819.0

Table A2

Total Number (N) and Weight in Grams (W) of Fishes Collected at the Natural Bank of the Stack Island Pool by Sample Period and Gear Type*

Species		August			September			October	November	January		
		EF	SN	GN	EF	SN	GN	EF	EF	EF	SN	GN
Longnose gar	N			1			1					
	W			2,260.0			5,600.0					
Shortnose gar	N			1	1		2	4	1			
	W			982.0	1,125.0		1,345.0	1,423.0	543.0			
Alligator gar	N								1			
	W								765.0			
American eel	N							3				
	W							3,337.0				
Skipjack herring	N	2			1							
	W	247.0			54.0							
Gizzard shad	N	113	1	11	8	2	2	3	7			
	W	9,029.0	2.7	3,847.0	519.0	26.6	804.0	203.7	549.0			
Threadfin shad	N	5	4		5	3		2				
	W	93.0	0.9		33.1	1.2		5.2				
Goldeye	N				1			5	1		1	1
	W				33.2			446.1	45.6		228.0	228.0
Carp	N				1			3	3			
	W				1,390.0			7,685.0	7,519			
Mississippi silvery minnow	N							5	2			
	W							32.4	13.3			
Speckled chub	N					1						
	W					0.1						
Silver chub	N		1			1						
	W		2.4			1.4						3.8
Emerald shiner	N		274			147			2	3		3
	W		92.5			60.5			4.3	4.8		4.8
River shiner	N		40			13				5		5
	W		7.7			3.3				0.7	0.1	11.7

(Continued)

* EF = electrofishing, SN = seine, and GN = gill net.

(Sheet 1 of 3)

Table A2 (Continued)

Species		August EF	August SN	August GN	September EF	September SN	September GN	October EF	November EF	January EF	January SN	January GN
Red shiner	N		2									
	W		1.1									
Silverband shiner	N		18			21					2	2
	W		2.4			3.2					0.2	0.2
Blacktail shiner	N	2	18			19					3	3
	W	8.2	3.4			2.5					0.4	0.4
Mimic shiner	N		2			2						
	W		0.9			0.2						
Bullhead minnow	N		2			4						
	W		2.0			1.3						
River carpsucker	N		2	2			1					
	W		0.4	1,724.0			1,080.0					
Blue sucker	N				1							
	W				2,710.0							
Smallmouth buffalo	N	1						14	22			
	W	1,274.0						17,055.0	44,405.0			
Blue catfish	N			3	1		4	3	6			
	W			6,115.0	80.0		3,100.0	762.2	179.7			
Channel catfish	N		1				2					
	W		1.9				881.0					
Flathead catfish	N	3		1	4							
	W	597.0		3,228.0	1,307.0							
Mosquitofish	N		2									
	W		0.4									
Brook silverside	N		4			1			1			
	/		5.1			1.1			2.4			
Inland silverside	N		32			4		1	1	1	2	3
	W		14.3			3.8		2.0	2.4	1.3	1.1	2.4
White bass	N			1	3							
	W			602.0	1,445.0							
Orangespotted sunfish	N		1									
	W		0.4									

(Continued)

(Sheet 2 of 3)

Table A2 (Concluded)

Species		August			September			October	November	January			
		EF	SN	GN	EF	SN	GN	EF	EF	EF		SN	GN
B'uegill	N	2	6		2	2		2		1	2		3
	W	4.5	0.6		61.0	0.2		63.5		79.2	0.9		80.1
Black crappie	N							1					
	W							235.0					
Sauger	N											1	1
	W											340.0	340.0
Freshwater drum	N		1	1	1		12	6	10				
	W		75.7	373.0	550.0		3,194.0	917.2	1,503.0				
Total	N	128	411	21	29	220	24	52	57	5	14	2	21
	W	11,252.7	214.8	19,131.0	9,307.0	105.4	16,004.0	32,167.3	55,531.7	85.3	3.3	568.0	656.6

(Sheet 3 of 3)

Table A3

Total Number (N) and Weight in Grams (W) of Fishes Collected in the Midpool Microhabitat of Stack Island Pool by Sample Period and Gear Type*

Species		August EF	August GN	September EF	September GN	October EF	January EF
Gizzard shad	N		8				
	W		2,179.0				
River carpsucker	N		1				
	W		326.0				
Blue catfish	N		5				
	W		6,041.0				
Largemouth bass	N		1				
	W		90.0				
Sauger	N		1				
	W		405.0				
Freshwater drum	N		3				
	W		547.0				
Total	N	0	19	0	0	0	0
	W	0	9,588.0	0	0	0	0

* EF = electrofishing and GN = gill net.

Table A4

Total Number (N) and Weight in Grams (W) of Fishes Collected at the Pool Sandbar of Ajax Bar Pool by Sample Period and Gear Type*

Species		August EF	August SN	August GN	September EF	September SN	September GN	October EF	November EF	January EF	January SN	January GN
Longnose gar	N	1		1								
	W	465.0		2,940.0								
Skipjack herring	N			2			8					
	W			198.0			968.0					
Gizzard shad	N	56	4	25	78	14	39					
	W	6,088.0	163.3	5,450.0	7,192.5	48.8	6,644.0					
Threadfin shad	N		185		14	1						
	W		295.3		105.4	0.8						
Mississippi silvery minnow	N				1							
	W				3.8							
Speckled chub	N		1									
	W		0.2									
Emerald shiner	N		33		2	52						
	W		12.1		1.9	10.5						
River shiner	N		42			62					1	
	W		4.8			8.8					0.9	
Silverband shiner	N		2			4						
	W		4.7			0.4						
Blacktail shiner	N					5						
	W					0.5						
Mimic shiner	N		1			1						
	W		0.1			0.1						
River carpsucker	N		119	3		46	3				1	1
	W		80.3	2,585.0		55.1	2,165.0				2.7	700.0
Smallmouth buffalo	N			1								
	W			1,166.0								
Blue catfish	N	1		2			6					1
	W	60.0		677.0			1,595.0					1,830.0

(Continued)

* EF = electrofishing, SN = seine, and GN = gill net.

Table A4 (Concluded)

Species		August			September			October	November	January		
		EF	SN	GN	EF	SN	GN	EF	EF	EF	SN	GN
Channel catfish	N						1					
	W						1,085.0					
Inland silverside	N		7			2						
	W		5.3			1.1						
White bass	N	1		1			1					
	W	212.0		804.0			245.0					
Striped bass	N	1	2									
	W	28,28.0	8.7									
Sauger	N											1
	W											884.0
Freshwater drum	N	1		5	1		2					
	W	140		965.0	11.0		310.0					
Striped mullet	N	2										
	W	1,427.0										
Total	N	63	396	40	96	187	60	0	0	0	2	3
	W	15,405.0	574.8	14,785	7,314.6	126.1	13,012.0	0	0	0	3.6	3,414

Table A5

Total Number (N) and Weight in Grams (W) of Fishes Collected at the Natural Bank of Ajax Bar Pool

by Sample Period and Gear Type*

Species		August			September			October			November	January		
		EF	SN	GN	EF	SN	GN	EF	SN	GN	EF	EF	SN	GN
Shovelnose sturgeon	N									3				
	W									1,833.0				
Paddlefish	N									1				
	W									1,920.0				
Longnose gar	N	2		1			1			2				
	W	742.0		745.0			2,320.0			10,000.0				
Shortnose gar	N	2		3	1		4	1		3				
	W	968.0		1,615.0	508.0		3,850.0	652.0		3,643.0				
American eel	N											1		
	W											231.0		
Skipjack herring	N	2		5	1		2				1			
	W	206.0		493.0	62.0		330.0				7.5			
Gizzard shad	N	110	76	38	32	5	34	16	1	15	11			1
	W	9,294.0	104.3	7,135.0	3,549.4	20.3	6,090.0	1,694.8	4.5	1,276.0	930.2			165.0
Threadfin shad	N	48	39		11	45		11	12		1			
	W	415.3	40.3		51.0	65.9		63.1	5.4		6.1			
Goldeye	N				1						5			6
	W				112.8						562.6			1,123.0
Carp	N	2			4			6						
	W	4,306.0			10,374.0			13,995.0						
Speckled chub	N								1				6	
	W								0.1				0.7	
Silver chub	N											1	1	
	W											2.2	0.9	
Emerald shiner	N		55		1	222		3	30		4		6	
	W		11.0		3.1	61.9		6.4	32.8		10.7		4.4	
River shiner	N		28			23			33				73	
	W		6.2			12.3			10.4				21.4	
Pugnose minnow	N		1			1								
	W		0.1			0.3								
Red shiner	N		1			4			3				1	
	W		1.9			0.4			2.5				0.1	
Silverband shiner	N	1	5			31			173		1			
	W	1.8	7.2			3.1			41.0		1.1			
Blacktail shiner	N		30			20			11				11	
	W		4.4			6.7			2.6				2.3	
Mimic shiner	N								3					
	W								1.1					
Bullhead minnow	N		13						1			1		
	W		1.4						0.1					

(Continued)

* EF = electrofishing, SN = seine, and GN = gill net.

Table A5 (Concluded)

Species		August EF	August SN	August GN	September EF	September SN	September GN	October EF	October SN	October GN	November EF	January EF	January SN	January GN
River carpsucker	N	1	3	2			1	11		1	1	6	1	3
	W	521.0	2.4	2,138.0			398.0	3,211.0		434.0	1,020.0	3,067.8	1.1	3,178.0
Quillback	N									1				
	W									728.0				
Smallmouth buffalo	N			1				7		1	1	4		1
	W			1,099.0				7,413.0		2,135.0	2,900.0	2,923.0		624.0
Bigmouth buffalo	N							2						
	W							2,396.0						
Black Buffalo	N											1		1
	W											1,391.0		2,458.0
Blue catfish	N	2		2	4		5	1		18	19			1
	W	615.0		2,792.0	695.2		1,304.0	886.0		17,199.0	5,502.5			1,088.0
Channel catfish	N				2				4		1	3		
	W				685.0				18.1		3.8	2,723.0		
Flathead catfish	N	2		1	2			1			1			
	W	1,871.0		567.0	253.7			628.0			1,420.0			
Mosquitofish	N								4					
	W								0.8					
Inland silverside	N		2			4		1	36					
	W		0.3			2.6		1.6	22.7					
White bass	N	2		1	7			9		3		2		1
	W	1,554.0		768.0	2,695.0			2,013.7		2,940.0		1,433.0		798.0
Striped bass	N	1						1						
	W	631.0						1,860.0						
Orangespotted sunfish	N								1					
	W								3.9					
Bluegill	N	1	3		3			3	1			15	1	
	W	15.0	0.5		360.0			79.3	0.1			921.0	0.2	
Longear sunfish	N				1							4		
	W				55.0							56.5		
Largemouth bass	N				1							1		
	W				240.0							269.0		
White crappie	N								1	1				
	W								8.0	157.0				
Black crappie	N							2	1					
	W							595.0	7.9					
Sauger	N				1			1		1				3
	W				358.0			273.0		292.0				1,193.0
Freshwater drum	N	2	1	3	1		4	10		7	1			
	W	301.0	1.8	607.0	130.0		819.0	1,068.9		1,269.0	490.0			
Striped mullet	N	1												
	W	400.0												
Total	N	180	257	58	73	355	51	86	316	57	47	39	100	17
	W	21,841.0	181.8	17,959.0	20,168.2	173.5	15,111.0	36,836.8	162.0	43,826.0	12,854.5	13,018.2	31.1	10,627.0

Table A6

Total Number (N) and Weight in Grams (W) of Fishes Collected Midpool of Ajax Bar Pool by Sample Period and Gear Type*

Species		August		September		October	November	January
		EF	GN	EF	GN	EF	EF	EF
Longnose gar	N		1					
	W		571.0					
Shortnose gar	N		4					
	W		4,580.0					
Skipjack herring	N						2	
	W						26.7	
Gizzard shad	N	2	34	15	8	3		
	W	177.0	7,500.0	1,530.0	2,136.0	110.0		
Threadfin shad	N					1		
	W					1.0		
River carpsucker	N		1					
	W		738.0					
Blue catfish	N		6		6			
	W		4,170.0		2,248.6			
Channel catfish	N				1			
	W				1,700.0			
White bass	N		1					
	W		187.0					
Sauger	N				2			
	W				826.0			
Freshwater drum	N		1		4			
	W		263.0		1,344.0			
Total	N	2	48		21	4	2	0
	W	177.0	18,009.0		8,254.6	111.0	26.7	0

* EF = electrofishing and GN = gill net.

Table A7

Total Number (N) and Weight in Grams (W) of Fishes Collected at the Ajax Bar Pool Dike Microhabitat by Sample Period and Gear Type*

Species		August EF	August SN	August GN	September EF	September SN	September GN	October EF	January EF	January SN	January GN
Shortnose gar	N			1			1				
	W			1,204.0			2,060.0				
Skipjack herring	N	1					3				
	W	7.9		–			630.0				
Gizzard shad	N	79	7	27	15		31	6			
	W	8,694.1	50.6	3,634.0	1,806.0		6,867.0	441.0			
Threadfin shad	N	13	147		1	8					
	W	121.9	130.2		3.4	5.3					
Goldeye	N										2
	W										116.0
Carp	N	1					1				
	W	1,857.0					2,720.0				
Mississippi silvery minnow	N		2								
	W		5.5								
Silver chub	N		4								
	W		7.8								
Emerald shiner	N		61			38					
	W		29.1			11.5					
River shiner	N		60			13					
	W		13.2			7.0					
Silverband shiner	N		11			3					
	W		18.1			0.3					
Weed shiner	N		1								
	W		0.7								
Blacktail shiner	N		3								
	W		0.5								
Bullhead minnow	N		2								
	W		0.4								

(Continued)

* EF = electrofishing, SN = seine, and GN = gill net.

Table A7 (Concluded)

Species		August			September			October	January		
		EF	SN	GN	EF	SN	GN	EF	EF	SN	GN
River carpsucker	N		4	6	1		12				
	W		11.3	5,533.0	285.0		9,000.0				
Blue sucker	N				1						
	W				1,370.0						
Smallmouth buffalo	N				1		1				
	W				840.0		1,310.0				
Blue catfish	N	3		1	3		15				
	W	15.3		468.0	1,116.0		7,565.0				
Channel catfish	N		1	1	2		1				
	W		1.8	261.0	1,730.0		760.0				
Flathead catfish	N	8			3						
	W	1,175.0			823.4						
Inland silverside	N		2			1					
	W		0.4			1.3					
White bass	N	2	1	2	11		7				
	W	910.0	6.3	1,038.0	4,688.0		2,709.0				
Sauger	N			1			2				
	W			370.0			575.0				
Freshwater drum	N	1	2	1	1		4				
	W	0.5	2.2	156.0	19.0		530.0				
Striped mullet	N	3									
	W	1,564.0									
Total	N	111	308	40	39	63	78	6	0	0	2
	W	14,345.7	278.1	12,664.0	12,680.8	25.4	34,726.0	441.00	0	0	116.0

Table A8

Total Number (N) and Weight in Grams (W) of Fishes Collected at the River Sandbar by Sample Period and Gear Type*

Species		August		September		October		November		January	
		EF	SN	EF	SN	EF	SN	EF	SN	EF	SN
Paddlefish	N	1									
	W	77.0									
Shortnose gar	N									2	
	W									2,533.0	
Shipjack herring	N							1			
	W							11.7			
Gizzard shad	N	20	4	44	10	16		4		2	
	W	2,632.0	98.2	5,843.0	75.3	1,923.0		582.0		154.0	
Threadfin shad	N	12	107	1	25	2	30				
	W	81.8	71.3	9.0	50.9	15.0	11.1				
Carp	N									1	
	W									3,229.0	
Mississippi silvery minnow	N		2		1	1	1	1	2		
	W		4.5		3.9	55	7.3	7.2	12.9		
Speckled chub	N		3		1		122		8		3
	W		0.3		0.2		22.0		1.7		0.9
Silver chub	N		2					2	8		
	W		3.0					15.5	24.4		
Emerald shiner	N		29		59		26		14	1	
	W		18.8		27.8		22.9		21.7	3.8	-
River shiner	N		32		96		91		49		7
	W		5.6		17.8		33.7		42.4		7.3
Silverband shiner	N		3		12		45		2		
	W		0.7		1.2		18.0		1.0		
Weed shiner	N		1								
	W		0.4								
Blacktail shiner	N		10		51		20				
	W		1.0		5.5		3.5				

(Continued)

* EF = electrofishing and SN = seine.

Table A8 (Concluded)

Species		August		September		October		November		January	
		EF	SN	EF	SN	EF	SN	EF	SN	EF	SN
Mimic shiner	N						10		1		
	W						3.8		0.3		
Bullhead minnow	N				2		11				
	W				0.3		3.2				
River carpsucker	N		29	2	38		24		5	8	2
	W		24.8	579.0	53.4		58.6		31.1	1,400.1	8.8
Blue sucker	N			1							
	W			2,600.0							
Smallmouth buffalo	N									3	
	W									4,425.0	
Blue catfish	N	3		5		1					
	W	2,378.0		2,670.0		92.0					
Channel catfish	N			2	1		48		5		
	W			3,690.0	0.6		95.8		8.2		
Flathead catfish	N	1									
	W	358.0									
Blackstripe topminnow	N		1								
	W		0.6								
Mosquitofish	N		1								
	W		0.1								
Brook silverside	N						1				
	W						1.6				
Inland silverside	N		20		12		7				
	W		17.6		12.0		2.3				
White bass	N			1							
	W			390.0							
Striped bass	N		1								
	W		4.5								
Freshwater drum	N		1	2			2	1			
	W		0.5	335.0			8.1	111.0			
Striped mullet	N	1									
	W	678.0									
Total	N	38	246	58	308	20	438	9	94	17	12
	W	6,205.0	251.9	16,116.0	248.9	2,035.5	291.9	727.4	143.7	11,744.9	17.0